Consumer Electronics DSTB/DMR Platform Vision Guide

Part II – Implementation Details

For 2005

Rev. 1.0

Revision History

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About the Intel® Consumer Electronics Platform Vision Guide

Welcome to Part II of the Intel® Consumer Electronics Platform Vision Guide (CE PVG) for 2005. This section describes the document and provides background information to aid in understanding its contents. Please refer to Part I of the Intel Consumer Electronics Platform Vision Guide for a general overview.

Purpose

Intel is focused on creating innovative solutions for the digital home where PCs and consumer electronics (CE) devices are networked to enable consumers to share and enjoy entertainment, communication, and information using any device, anywhere and any time in the home. CE platforms based on Intel® Architecture accelerate the industry convergence of compute density and Internet connectivity by providing the capabilities needed to enhance flexibility, scalability, and features for the highly competitive CE market segment.

Specifically, this guide focuses on the following:

- Technical system features required to support the usage models of the digital home
- Technical details of implementation of the platform vision
- Important specifications required to enable each function.

The overall goal is to provide implementation guidelines for a family of CE platforms designed to meet the needs of end-users.

Audience

This guide is intended for:

- Strategic planners, architects and designers who define and design CE hardware and software products
- Marketing and strategic marketing managers who specify requirements for competitive CE products designed to meet the needs of emerging usage models.

Contents

Figures

Tables

1 Platform Summary

1.1 Introduction

This chapter provides an overview and summary of technology enhancements available for use in IP Digital Set-Top Box (IP-DSTB) and Digital Media Recorder (DMR) platforms in 2005.

IP-DSTB and DMR client devices will play an essential role in the 2005 digital home. These consumer electronics devices are designed to enable a service provider to cost-effectively provision a broad spectrum of pre-packaged services, including video, data, and voice services, to a large installed base of consumers. The digital home environment will rapidly evolve in 2005 as new digital home devices are deployed, requiring platforms with the flexibility that service providers demand. The continuing evolution of consumer usage models for digital media, the identification of consumer preferences for specific services, new standards, CODECs and protocols for IP video and voice, and the non-stop development of new applications and middleware will make increasing demands on IP-DSTB and DMR platforms.

The emergence of video and audio CODECs is one example of the continuing evolution of industry standards. The flexibility of Intel Architecture platforms can help to support the transition from MPEG-2 to MPEG-4, MPEG 4.10, VC1 and Windows* Media 9. Other new standards are also emerging within the digital home, including Intel® Networked Media Product Requirements (Intel® NMPR), Universal Plug and Play (UPnP), and Digital Living Network Alliance (DLNA) standards for interoperability in addition to Digital Transmission Content Protection (DTCP) over IP.

In order to support cost-effective deployments, IP-DSTBs and DMRs designers will need to consider the following requirements in 2005:

- Processing performance to handle the next-generation applications and services
- Processing headroom and scalability based on a flexible platform architecture, to support emerging video CODECs
- Validated platform solutions for reliability and fast time-to-market
- Cost-effective platform configurations
- Availability of development tools and software
- Platform building blocks with long lifecycle support.

Intel Consumer Electronics Group provides components and platform configurations designed to help original equipment manufacturers (OEMs) and original device manufacturers (ODMs) develop highly differentiated and scalable devices while meeting time-to-market deadlines. Intel® Architecture IP-DSTB and DMR platforms are also part of end-to-end solutions from Intel that enable the delivery of new generations of Internet Protocol digital media. Intel platforms can deliver these capabilities today, thanks to new features and technology in silicon, hardware, and software building blocks delivered to the CE ecosystem.

The following sections of this Platform Vision Guide establish the foundation for the implementation of CE devices using Intel building blocks:

- A re-cap of consumer usage models
- New platform features and technologies

- Software considerations
- Operating system support

1.1.1 A World Networked for Video

As high-speed networks proliferate, exciting opportunities are emerging for telecommunications providers to build new revenue streams by offering their subscribers a broad range of new services. The seamless delivery of high-quality video is one of the most promising avenues for value-added services, with technologies already paving the way for TV signals to be transmitted across DSL, fiber, and wireless networks using Internet Protocol (IP).

Globally, DSL is the fastest growing high-speed access technology, with properly configured DSL networks capable of providing download throughput ranging from 0.5-25 Mbps or greater. At the same time, compression technology has advanced significantly, as have the storage capacities of removable and fixed hard drives. The rapid evolution of video-oriented technologies has spurred service providers to seriously consider the financial advantages of delivering DVD quality video. When this capability is combined with the ability to offer games or other interactive services, service providers can deploy a compelling “triple-play” of voice, data, and video services, with the potential of enhanced average revenue/user.

Intel believes that the demand for these services is already increasing, and this view is widely shared throughout the industry. Strategy Analytics estimates that the number of consumers using television and video services delivered via IP networks will grow from 110,000 in 2002 to an impressive 20.44 million by 2008 (source: Strategy Analytics). This trend represents significant new revenue generating opportunities in the near-term, representing a source of previously untapped potential that can be seized by forward-thinking companies with the ability to turn their CE vision into reality.

1.2 Usage Models

The combination of PCs, IP-DSTBs and DMRs connected over a digital home network provides multiple options for sharing digital media, as illustrated by the following consumer usage models.

1.2.1 Streaming Video

You are working to finish a project using your home PC in the den, but you don’t want to miss a favorite TV program. You use a software application on your PC to select your family’s entertainment center from an on-screen menu. You have the option of selecting the TV channel you want from an Electronic Program Guide (EPG) and viewing the program in a window on your PC screen or recording the program on the IP-DSTB or DMR for later viewing. You can record your show while family members are viewing other programs.

1.2.2 Sharing Digital Photos

You have transferred digital photos from your cell phone digital camera to your Entertainment PC, enhanced the snapshots with a software application and cataloged them in an electronic album. Now you want to share the results with other members of your family. Using the IP-DSTB on your TV, you access the photos stored on your PC and display them on the TV’s big screen for easier viewing by the entire family.

1.2.3 Listening to Music Throughout the Home

You are entertaining guests in your back yard and want to provide background music to set the mood. You select MP3 music tracks stored on the DMR in the living room and bring up an on-screen menu to send your selections to an audio system on the patio.

1.3 New Features and Technology

IP-DSTB and DMR platforms should provide the processing headroom to support future generations of consumer electronics applications and services, with the system-level bandwidth to support high-quality streaming video including multiple video and graphics data streams.

Compared to previous Intel Architecture CE platform designs, Intel IP-DSTB and DMR platform configurations for 2005 include processors and chipsets designed to significantly enhance both application processing and system-level performance, while helping to minimize the system bill-of-materials.

Highlights of 2005 platforms include:

- Support for Intel® Celeron® M –class processors
  - Increased platform performance
  - 400 MHz synchronous processor-side bus (PSB)
  - Enhanced thermal performance: No CPU fan required for Intel® Celeron® M 600 MHz CPU operating at 7 W Total Dissipated Power (TDP)
- Graphics and Memory Controller Hub (GMCH) with integrated DDR SDRAM controller (266/333 MHz) for enhanced memory bandwidth
- Integrated 266 MHz graphics core for high-performance 2D and 3D graphics
- Support for Microsoft Windows* CE 5.0

1.3.1 DDR Memory Support

Intel's third-generation Intel IP-DSTB and DMR configurations provide a flexible range of high-performance processors, support for a faster processor-side bus, and higher-bandwidth double data-rate (DDR) memory. The platform configurations are based on the Intel® chipsets in validated combinations with Intel Celeron M-class processors.

Intel chipset plans include a Graphics and Memory Controller Hub (GMCH) and an ICH4-M I/O Controller Hub (ICH). Intel® Accelerated Hub Architecture provides an efficient high-bandwidth communication channel between the GMCH and the ICH. The use of high-performance, Intel Celeron M-class processors with enhanced low-power features provides application processing headroom, while faster busses and DDR memory enable the data throughput required to support multiple digital video streams with high levels of quality.

DDR memory has important advantages for designers of CE client devices, including reduced latency that can improve system-level performance by eliminating potential data throughput bottlenecks. The enhanced platform also improves the scalability of Intel IP-DSTB and DMR platforms designed to support standard-definition (SD) digital video and graphics. Available in high volume, DDR system memory is a cost-effective solution that can help reduce bill of materials costs compared to conventional SDRAM.

The GMCH component contains a processor-side bus (PSB) controller that supports a 400 MHz integrated graphics controller with a core frequency of up to 266 MHz, and integrated DDR SDRAM controller supporting up to 2 GB total of 266/333 MHz DDR memory using one DIMM. The DDR memory subsystem can move data at a rate of 2.66 GB/sec. In addition, the controller supports Unified Memory Architecture (UMA) that helps to further reduce platform costs by storing video and graphics data in system memory.

The ICH component integrates USB host controllers for USB 1.1 and USB 2.0, an Ultra ATA 100/66/33 controller, a LAN controller, and an AC'97 2.3 digital controller, while providing interfaces for PCI and Low Pin Count (LPC) devices, in addition to a firmware hub Flash BIOS.

1.3.2 Wireless Networking

The growing use of broadband internet connection in homes and the proliferation of digital content is driving the growth of wireless networking in the digital home. According to In-Stat/MDR in 08/04 report "*WLAN ICs: WiFi-Silicon for PCs, Consumer Electronics and IP Telephony*" more than 50 percent of all WiFi silicon, or 55 million units, will ship into the home in 2005 on PCs, CE devices, and access points (source In-Stat/MDR, 8/04). As its name suggests, wireless networking adds the ability to link consumer electronic devices without fixed wiring. It allows the IP-DSTB or DMR to link with other consumer electronic devices such as digital media adapters, wireless monitors, entertainment PCs and game consoles. It should also be noted that there are still several technical challenges involved with the use of WiFi in CE devices. These challenges include range (especially for larger sized US homes), throughput, Quality of Service (QoS) for the real-time sensitive multimedia content, and ease of set-up and use. These technical challenges are being addressed by upcoming standards such as 802.11e and 802.11n. See Appendix D for additional details on Wireless Technologies.

Intel Architecture-based IP-DSTB and DMRs offer flexibility to add wireless capability via a PCI based add-in card. The add-in wireless or WiFi solutions should comply with the IEEE 802.11a or IEEE 802.11g or IEEE 802.11b/g specifications.

IEEE 802.11b/g wireless networking provides flexible "no new wires" connectivity between Intel Architecture IP-DSTB and DMR platforms and digital media adapters, wireless access points, and video monitors and game consoles with wireless networking support. Intel Architecture based IP-DSTB and DMRs support wireless capability with Intel® PRO/Wireless 2100 Series Network Connections enabled by an add-in card.

1.3.3 Digital Home Software Stack

Today's consumers increasingly buy multi-function devices and place them in various rooms throughout the home. Interactive services targeted at a single platform without considering the requirements of a networked digital home will no longer satisfy many consumers. The consumer should be able to use a CE device of choice to access a service at any time and at any location.

As shown from Forester Research in Figure 1, in the future many consumers will buy technology that fits into their digital home, rather than following the device-by-device buying decisions. To meet this demand, the consumer electronics industry must support multi-function and multi-service models for services on different devices and terminals:

- Television for audio/video content with simple interaction such as PVR and interactive television
- PC for Internet services with complex interaction such as searching and buying
- Mobile platforms for personalized and location based services such as personalized news alerts.

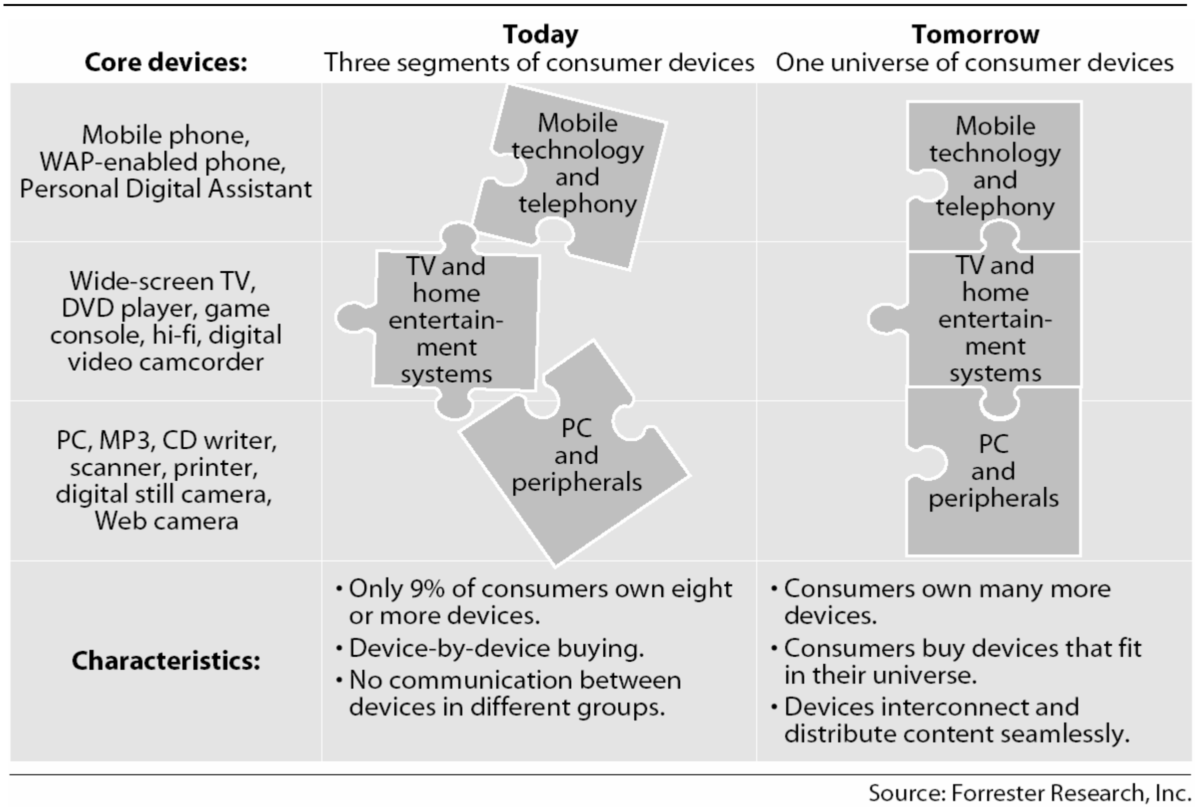


Figure 1. Consumer Device Segmentation vs. Alignment

According to Forrester Research, homes will contain a set of Internet ready terminals to interact with the consumer, and control of the terminals will be needed in a free and unbounded fashion, for example by using a PDA.

An industry-wide effort, the Digital Living Network Alliance (DLNA), is creating a set of standards to make these usage models interoperable, enabling the use of Intel Architecture with home networking and multimedia software solutions including reference designs and tool kits. Intel® NMPR is a set of guidelines that enables manufacturers to design devices to meet DLNA specifications. The digital home software stack provides developers with solutions that allow them to easily construct tailored platform configurations that meet the requirements of particular price/performance points, consumer electronics usage models and emerging interoperability standards as described in Figure 2.

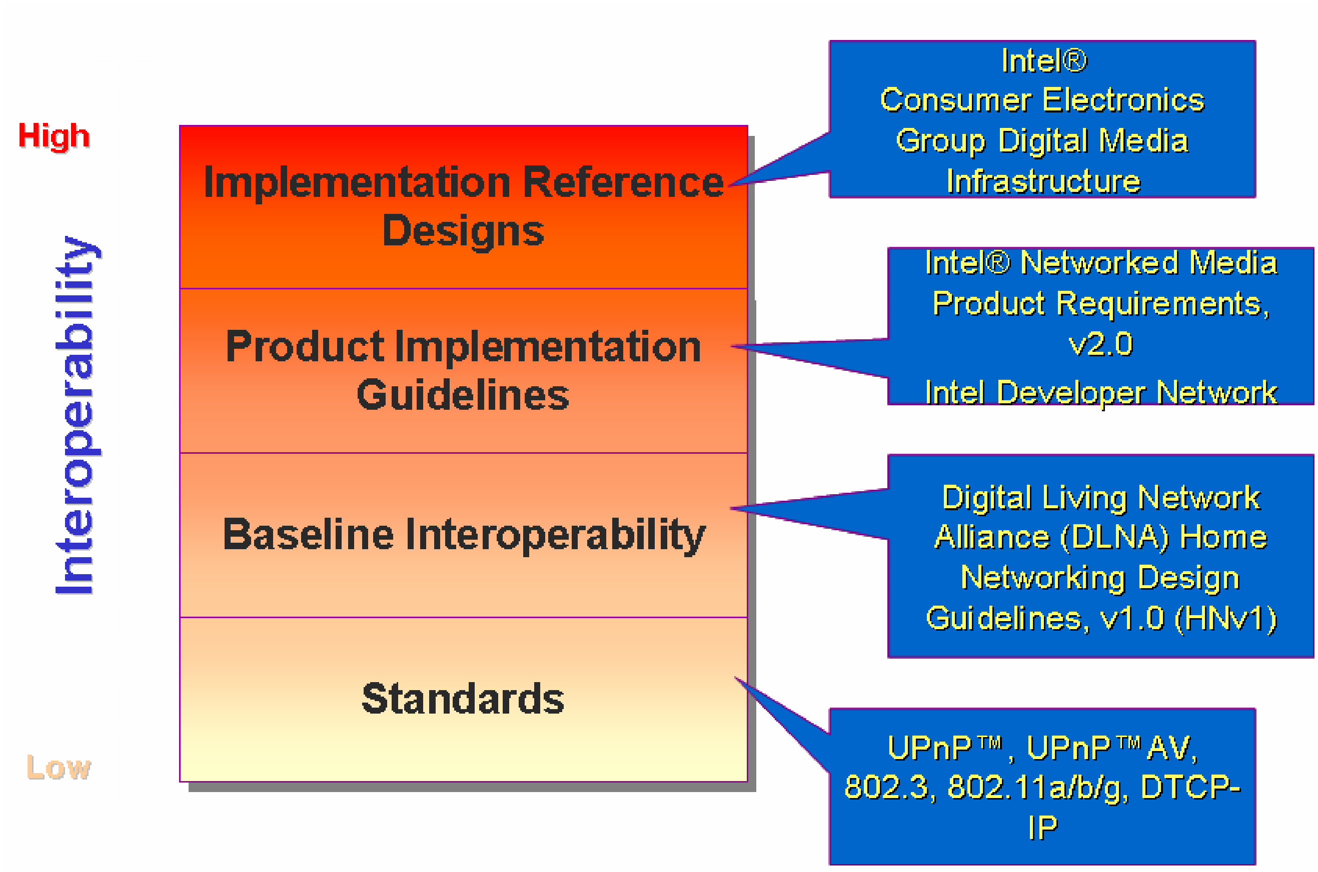


Figure 2. Digital Home Software Stack

Intel's DMI (Digital Media Infrastructure) is a comprehensive and fully integrated reference software solution that can be readily used by an OEM/ODM/ISV to gain DLNA and/or Intel NMPR conformance. The Device Authoring Toolkit is a set of templates that are DLNA-compliant and conformant with Intel NMPR. These templates can be used for customization by the vendor.

Non-PC users present the automotive, mobile, and CE industries the challenge of providing a simple and effective user interaction for home and mobile communication. Where home networking can be made consistent, obvious and natural, the whole community may adopt this style of communication[1].

One of the key challenges in this area is device reservation. Using current consumer devices, the device and its users are located close together. Thus, it is easy for users to see if a resource is in use. In a networked environment, the device or service and its users may be in different locations. This can make it harder for a user to see if a resource is already in use. Adding reservation and security mechanisms to devices and services in digital networks, including UPnP networks, is mandatory because of the existence of scarce resources and content protection.

[1] Multi Service Models for Non PC users; P.Hulsen, E.Vlemmix,P Vartiainen, J Leinonen

Intel's home networking team is actively investigating other areas including Remote User Interfaces, QOS, and Digital Rights management (DRM). These areas will be presented in greater detail in Sections 4.2.4 and 4.3.1, respectively.

1.4 Operating System

1.4.1 Microsoft Windows* CE

Microsoft Windows CE combines an advanced real-time embedded operating system with tools for creating connected small-footprint devices. The features in Windows CE are optimized for devices that require rich networking and communications standards, a real-time kernel, multimedia and Web browsing capabilities and smaller footprints.

The features of Windows CE include the following:

- Reliable core operating system services
- Network services that can remotely authenticate, authorize, administer, and update new applications and operating system services
- Support for personal area networks (PAN), local area networks (LAN), and wide area networks (WAN)—including Bluetooth and 802.11

These local and network security features support data types that can be consumed, stored, and transmitted to and from Windows CE intelligent network devices. Intel Architecture CE platforms have been optimized with Windows CE 4.2 and 5.0.

1.4.2 Linux in Consumer Electronics

There is a significant effort in the CE community to converge and standardize on one Linux implementation. Known as CELF (Consumer Electronics Linux Forum), Intel is participating to help foster new capabilities that CE customers are demanding due to its robustness and cost.

CELF has developed and published its baseline Linux source code to make available for download and review by the open-source community. The source tree includes initial improvements to startup and shutdown time, real-time functionality, ROM/RAM size requirements and power management that address the needs of Linux based devices. Intel Architecture platforms currently support RedHat 8.1 and CELF patches for Linux v 2.6.9.

1.4.3 Board Support Packages

Intel offers Board Support Packages (BSPs) for Windows* CE 4.2 and 5.0; Platform Support Packages (PSPs) for Linux Red Hat 8.1; and CELF patches for Linux v 2.6.9 for many platforms. The performance and capabilities of each operating system implementation have been tuned for the particular configuration selected.

2 Consumer Electronics Features

2.1 Introduction

Intel provides end-to-end development solutions for platforms including Intel® Architecture IP-DSTB and DMR client devices that enhance the delivery of new generations of IP digital media and services. These devices provide high-performance and advanced functionality enabled by Intel® technologies, implemented through silicon, software and platform building blocks from Intel and the CE ecosystem. Many of the features and capabilities described below are currently available in solutions provided by leading consumer electronics ecosystem vendors. See Appendix A for a list of vendors who support Intel® Architecture IP-DSTB and DMR platforms.

2.2 DVD Player/Recorder

DVD players are commonplace in today's homes. The ability to burn DVDs makes it possible for consumers to capture and create a rich library of premium and/or personalized content on today's standard DVD Players. With the minimum storage size of 4.37 GB on a single layer DVD, the DVD player/recorder also makes for an excellent storage/archive medium. Table 1 lists several types of DVD drives.

Table 1. Types of DVD Drives

Drive Type	Discs Written	Discs Read
CD-R/RW	CD-R/RW	CD-R/RW
CD-RW/DVD combo drive	CD-R/RW	CD-R/RW, DVD+/-R/RW
DVD-R/RW	DVD-R/RW	CD-R/RW, DVD+/-R/RW
DVD+R/RW	DVD+R/RW	CD-R/RW, DVD+/-R/RW
DVD+/-R/RW	DVD+R/RW and DVD-R/RW	CD-R/RW, DVD+/-R/RW
DVD-RAM	DVD-RAM	DVD-RAM

Along with the drives, there are multiple DVD formats, as described in Table 2.

Table 2. DVD Formats

Drive Type	Features	Description
DVD-5	4.37 GB of data storage	Single layer
DVD-9	7.95 GB of data storage	Dual layer
DVD-10	8.7 GB of data storage	Dual layer
DVD-R/RW	Write once, write multiple times	"Dash" format, sequential
DVD+R/RW	Write once, write multiple times	"Plus" format, packetized

The DMR can incorporate DVD capability. Key considerations for software required to add this capability are described below.

2.2.1 DVD Software Considerations

There are three general software considerations for DVDs: Authoring, Playback and Burning. Intel CE platforms support all three, including various permutations:

DVD Authoring

- Basic editing of content before burning to DVD
- Create menu for DVD
- Add chapters to DVD

DVD Player

- Compatible with DVD-RW
- 5.1 audio support
- Wide screen or standard screen display
- Compatible with Remote Control

DVD Burning

- DVD R/W drive support
- DVD-R/-RW or DVDE+R/+RW(support for both is preferable)
- DVD-ROM, DVD-Video format support
- CD-DA, CD-ROM(XA), CD Extra, Video CD, Picture CD, CD Text, multi-session support
- IEEE-1394a camcorder to DVD support
- USB 2.0 camcorder to DVD recording
- DVD duplication
- Data DVD Burning
- Digital Photo Editor
- Burn a DVD/CD directly from photo editing application

2.2.2 DVD Hardware Drive Considerations

DVD burning requires the following set of DVD drive capabilities:

- Write speed (minimum): 4x DVDR, 2x DVD-RW, 16x CD-R, 10x CD-RW
- Read speed (minimum): 8x DVD-ROM, 32x CD-ROM
- Read modes/media:
  - DVD-R/-RW, DVD+R/+RW, or both (preferable)
  - DVD-ROM, DVD-Video
  - CD-DA, CD-ROM (XA), CD Extra, Video CD, Super Video-CD, Picture CD, CD
  - Text, multi-session
- ATAPI compatible
- 2 MB buffer
- UDMA modes 0-2+, PIO modes 0-4

Platforms based on Intel® Architecture may support this capability, but is not directly supplied by Intel.

2.3 Networking

Connectivity for the digital set top box includes support for wired and wireless solutions via an integrated Ethernet LAN controller (IEEE 802.3) and WiFi (IEEE 802.11) options.

2.3.1 Ethernet

Networking functions are implemented using the Intel® 82562ET/EM LAN controller. The Intel 82562ET/EM is a 10/100 Mbps Fast Ethernet Controller connected through the ICH4-M LAN Connect Interface. The 82562ET/EM includes a 32-bit PCI controller that provides enhanced bus mastering capabilities and enables the LAN controller to perform high-speed data transfers over the PCI bus.

The following summarizes the ICH4-M LAN controller features:

- Compliance with Advanced Configuration and Power Interface (ACPI) and PCI power management standards
- Support for wake-up on interesting packets and link status change
- Support for remote power-up using Wake on LAN (WOL) technology
- Deep power-down mode support
- Low power with less than 300 mW power consumption in active transmit mode
- Reduced power in "unplugged mode" at less than 50 mW.

For additional information, refer to the following sources:

- Intel® 82562 Family of Platform LAN Connect Solutions
  http://www.intel.com/design/network/products/lan/controllers/82562.htm
- Intel 82562 Family of Platform LAN Connect Solutions Technical Documents
  http://www.intel.com/design/network/products/lan/docs/82562_docs.htm
- Intel Consumer Electronics Software Downloads
  http://developer.intel.com/design/celect/swd/index.htm
- Intel 82562 Family of Platform LAN Connect Drivers
  http://downloadfinder.intel.com/scripts-df/Product_Filter.asp?ProductID=998

2.3.2 Wireless Networking

IEEE 802.11 is the family of specifications developed by Institute of Electrical and Electronics Engineers (IEEE) for wireless LAN technologies to provide a wireless interface between a client and a base station. The 802.11b standard provides 11 Mbps in the 2.4 GHz band. The 802.11a standard uses the 5 GHz band and can transmit wireless data up to 54 Mbps. IEEE 802.11g is the standard for the 2.4 GHz frequency with transmissions up to 54 Mbps.

Today's wireless standards are geography-centric. When implementing wireless for a specific country, please research the standards before selecting the technology for implementation. Intel Architecture based IP-DSTBs and DMRs support wireless capability with Intel® PRO/Wireless 2100 Series Network Connections enabled by an add-in card.

The descriptions below explain the benefits and limitations of the more common of the standards:

- **802.11b:** 802.11b (commonly known as "Wi-Fi") describes the IEEE wireless networking standard for a WLAN that operates in three channels within the 2.4 GHz radio band. 802.11b-based WLANs are far more common than 802.11a or 802.11g networks and can achieve a

maximum data rate of 11 Mbps per second at distances up to approximately 300 feet. 802.11b was the first WLAN technology offered to consumers and enabled the creation of instant wireless networks in offices and homes. There are occasional interferences with microwaves and cordless phones.
- **802.11a:** 802.11a describes the wireless networking standard for a WLAN that operates in 12 channels of the 5 GHz radio band (ISM or Industrial Scientific Medical frequency band) at up to 50 feet. IEEE 802.11a-based WLANs can achieve a maximum speed of 54 Mbps, providing nearly five-times faster networking data rate than 802.11b, and can handle more traffic than 802.11b-based networks. 802.11a is not backwards compatible with 802.11b, however, there is less interferences from operating at this frequency bandwidth.
- **802.11g:** 802.11g is a proposed standard, describing a wireless networking method for a WLAN that operates in three channels of the 2.4 GHz radio band (ISM). By using OFDM (Orthogonal Frequency Division Multiplexing) technology, 802.11g-based WLANs will be able to achieve a maximum speed of 54 Mbps. 802.11g-compliant equipment, such as wireless Access Points, are able to provide simultaneous WLAN connectivity for both 802.11g and 802.11b equipment.

2.3.3 Residential Gateway

Wireless networks add the ability to link consumer electronic devices without requiring fixed wiring. Wireless integration in the CE platform considerations include the following:

- Transceiver and antenna type
- Environment, EMC and regulatory requirements.

Platforms based on Intel® Architecture may support the residential gateway capability, but is not directly supplied by Intel.

2.3.3.1 Residential Gateway Software Considerations

A comprehensive software stack that supports both Station (STA) and Soft Access Point (Soft AP) is required to implement a residential gateway:

Station:

- 2.4 GHz b/g modes
- Power management ACPI 2.0
- Antenna Diversity-detection for one or two antennas and diversity is turned on appropriately
- Wi-Fi certification
- Operation System support for Windows CE and Linux
- WEP, WPA, and MAC access list security

Soft Access Point (Soft AP):

- Users will be able to configure the SSID for the Soft AP through the GUI.
- Channel Selection: Soft AP with manual selection of b/g. The default is b/g (dual mode).
- Ability to disable/enable the MAC access list. The MAC access list is a list of MAC addresses of clients who are allowed on the wireless network. Up to 50 MAC addresses will be supported.
- Basic security through WEP settings, which can be disabled through the soft AP GUI.

- Interoperation with several Virtual Private Network (VPN) clients including Cisco, Microsoft, Checkpoint, Nortel, and Netstructure.
- Compatible with Remote Control.

2.3.3.2 Residential Gateway Antenna Considerations

Antenna considerations include:

- Permanent antenna connector attachment requirements for 802.11a
- Unique connector requirements for 802.11a, 802.11b, 802.11g
- Antenna and card certification requirements
- RF safety testing requirements
- Product certification timelines.

Antenna vendors can work with you to ensure your system is compliant with regulatory requirements for countries where your product will be marketed and sold.

2.4 Audio

CD-quality multi-channel audio is increasingly expected in home consumer electronics devices. Platforms based on Intel® Architecture support this capability as outlined in AC '97. All references to AC ’97 in this document refer to the Audio Codec ’97 Component Specification, Revision 2.3. For further information on the operation of the AC-link protocol, see the AC ’97 specification.

The AC ’97 controller features include:

- Multiple sample rates up to 48 kHz, 20-bit sample resolution
- Single modem line
- Independent bus master logic for these inputs
  - Dual Microphone input
  - Dual PCM Audio input (2-channel stereo per input)
  - Modem input
- Independent bus master logic for these outputs
  - PCM audio output at 2-, 4-, or 6-channel audio
  - S/PDIF output
  - Modem output
- Configure up to three CODECs with three AC_SDIN pins

Figure 3 illustrates example configurations for AC '97 Rev 2.3 for audio

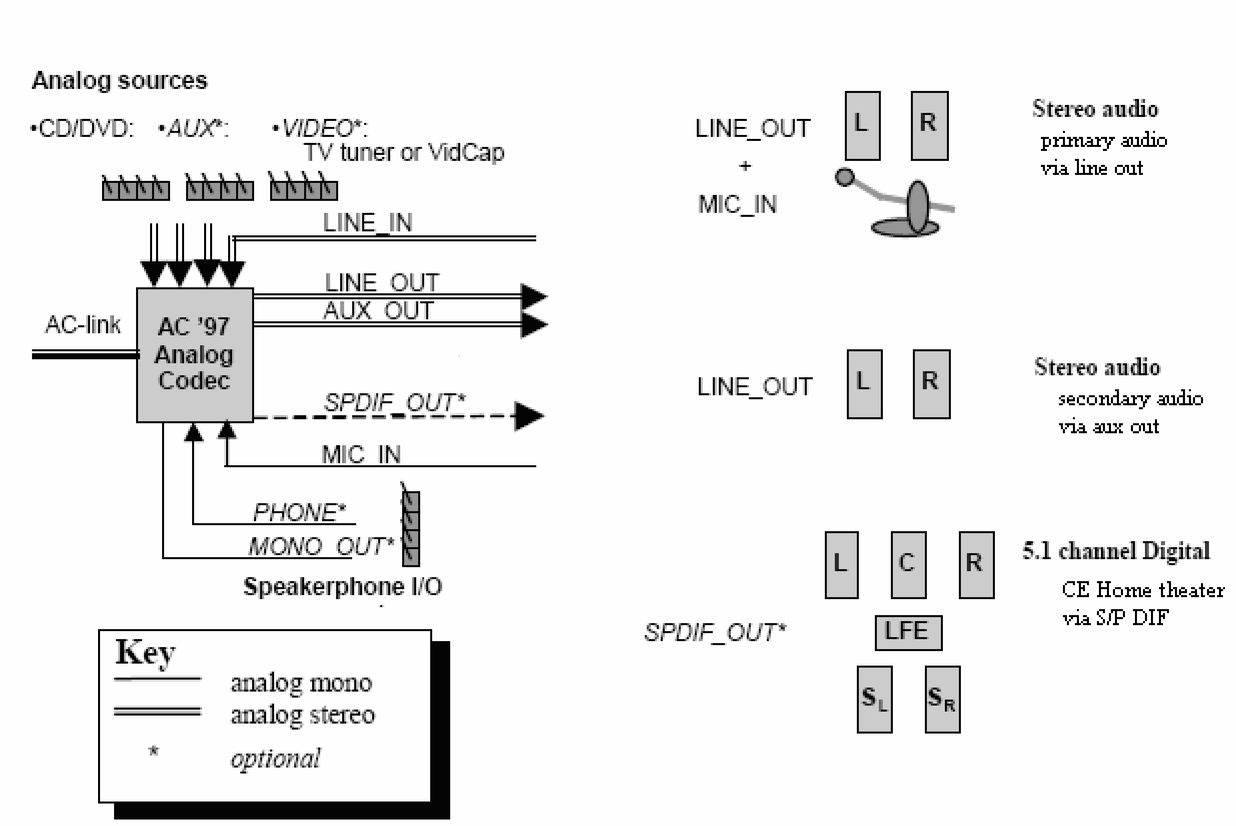


Figure 3. Example Configurations for AC '97 Rev 2.3

For additional information, refer to the following:

- Audio Technologies: http://www.intel.com/technology/computing/audio/index.htm
- Intel Consumer Electronics Software Downloads
  http://developer.intel.com/design/celect/swd/index.htm

2.5 Personal Video Recorder (PVR)

Intel platforms provide the ability to build in Personal Video Recording (PVR) functionality via a third party vendor (TPV) solution. While PVR functionality is dependant on the TPV software stack, it typically includes the following features:

- Pause, rewind, and instantly replay live TV
- Digitally record TV shows or video
- Playback recorded programs while continuing to record in real time (time-shifting)
- Multiple recording formats: DVD/VCD/MPEG-2/MPEG-4
- TV recording scheduler.

By combining a PVR and Electronic Program Guide (EPG) information, users can search future listings and select future programs to record with the click of a remote.

Several components are required to implement PVR capability into products. A hard disk drive (HDD) records incoming content. The amount of programming time that the hard disk can store is dependant on three factors:

- The size/capacity of the hard disk drive
- The video format of the content being recorded
- The encoding algorithm implemented by the PVR software.

If the box is designed to receive and record analog signals a digitizer and encoder is required. In most cases a TV capture subsystem or card will include an RF tuner and Demodulator whose purpose is to isolate the desired channel to record. After the tuning a digitizer and an encoder (in most cases an MPEG-2 encoder) are used to convert the video and audio to compressed data that is stored on the HDD for later viewing. Figure 4 shows an example of this configuration.

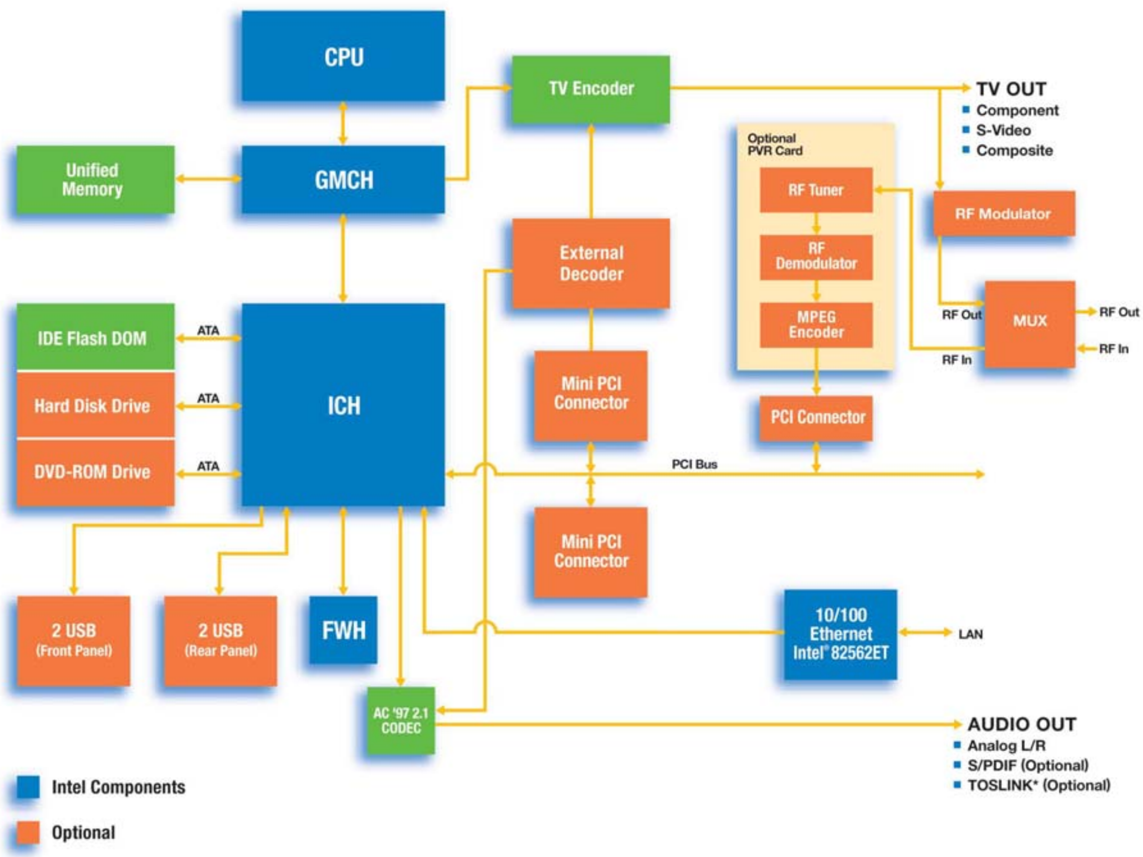


Figure 4. PVR Configuration Example

It should be noted that the configuration described here enables the user to manipulate only one live stream at a time. To simultaneously record and watch different (terrestrial) channels would require an additional tuner card or supporting components.

2.5.1 PVR Software

The primary functionality of the DMR is implemented through the personal video recording (PVR) software stack. This element of the platform software is often tightly coupled to the Media Building Blocks software, in addition to the Retail Consumer Electronics Middleware capabilities that can be found in an advanced DMR to provide the capabilities typically found in a Digital Media Adapter.

The PVR software enables simultaneous viewing and recording of the same video stream, providing the ability to pause "live TV", rewind and fast-forward while recording. If the DMR platform design supports multiple tuners, many PVR software offerings provide the extended capability to record more than on program simultaneously. To help access, manage and control the PVR capabilities, an EPG is integrated with the PVR software. Based upon the service provider, the EPG could list upcoming programs for the next 14 days. Some extensions of this EPG service also support context, title and other search capabilities as well as the management of easily recording favorites, and providing recording suggestions based upon prior viewing habits.

Accessing the on-line EPG and control of the DMR platform is provided by a remote control. Simple left, right, up, and down arrow buttons access and control selections of the graphical user interface, where typically selected options can be highlighted on the TV screen and can be enabled using an enter key on the remote control unit.

3 Consumer Electronics Software and Services

3.1 Introduction

Consumers will be able to use an IP-DSTB or DMR to deliver content to a variety of connected CE devices. This chapter describes the advanced capabilities these devices must support and the software and services that are needed to enable this in-home content delivery model.

3.2 IPTV

IPTV is a system that delivers TV-quality video such as VoD, education video content, traditional and premium TV programs and other content over existing and newly laid IP networks through the use of industry-adopted technologies including advanced video CODECs, like VC1 or MPEG-4 AVC. IPTV provides new opportunities for delivering services that increase consumer satisfaction and loyalty by offering virtually limitless programming with better navigation and digital video recording capabilities. IPTV also provides opportunities for unique service bundles with voice and data products, including VoIP, e-mail, instant messages, and Web browsing. IPTV can be easily extended beyond a digital TV solution and integrated with digital media applications in the home, that span across multiple devices, including simple and secure access to photos, music, and video located anywhere on a home network.

IP-DSTB designs based on the Intel® 854 GMCH are designed to output video directly to a display device that contains the display processing elements such as scaling, de-interlacing, noise reduction, color conversion, and frame rate conversion. The platform also enables software decode of popular media formats including Windows* Media 9 Series (VC1), DivX*, MPEG-2, MPEG-4, MP3, WMA , JPEG, and others, enabling content located on the network to be easily rendered on the TV. Figure 5 shows a block diagram of the Intel 854 GMCH based IP-STB. The Intel 854 GMCH based platform with third-party discrete silicon can have the complete functionality for the IPTV.

The IA based products provide digital media player functionality for connecting to a Home PC network through Ethernet or wireless in addition to typical TV functionality and operation. The platform also enables standard definition graphics capability for rendering advanced On Screen Displays (OSDs), EPGs and menus, greatly surpassing the 16/64/256 color OSD enabled by today's commercially available video processors.

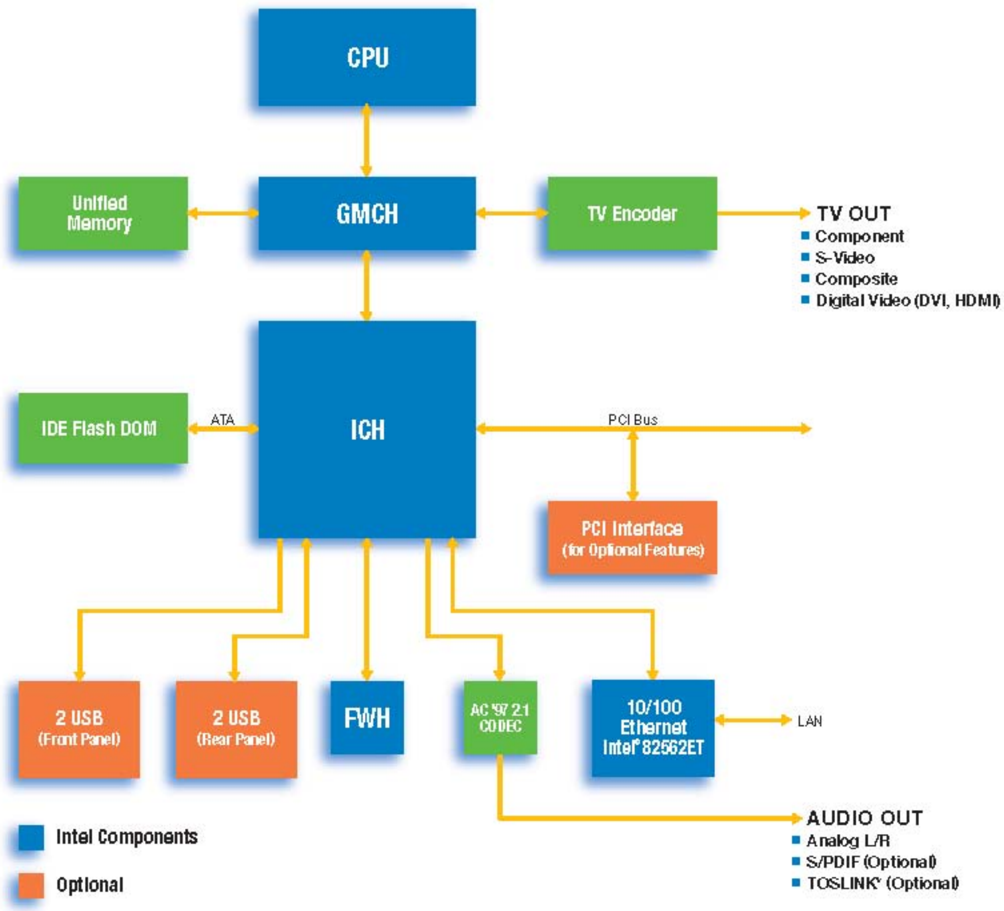


Figure 5. Block Diagram of an Intel® 854 GMCH Based IP-STB

3.2 VoIP

Voice over Internet Protocol (VoIP) uses the IP network to carry voice conversations. VoIP conversations can be held with devices such as phones, PCs, and mobile handheld devices.

VoIP capability enables service providers to support traditional IP telephony applications in addition to video-phone services. Incoming packets are routed into the platform through the ICH and GMCH to the processor, which runs the call-processing application. To permit two-way voice functionality, the platform must include circuitry that captures incoming voice from a headset or hands free microphone. In addition an application is required to manage how the user receives and places voice calls. The low-level software also includes algorithms for compression and decompression of audio – referred to as audio CODECs – as well as implementation of standard packetization and depacketization of IP packets containing the phone call data or voice. The addition of a camera enables the platform to support video-phone applications. Two-way

applications are enhanced with services such as call-waiting, caller-ID and the ease of transfer of other data such as graphics and slides.

The IP-DSTB platform also supports online gaming applications. Game input data is received through the Ethernet controller and routed through the ICH and GMCH to the processor. Players can also communicate with each other while a game is in progress using the platform's VoIP capability.

A typical Intel Architecture chipset based IP-DSTB, also requires a simple subscriber line interface (SLIC) and a conventional (analog) telephone handset plugged into the SLIC, to support VoIP. The SLIC works with the telephone like a conventional Central Office (CO) telephone exchange. The SLIC digitizes the media stream and exchanges it over the PCI bus with an application running on the host processor. This application controls the telephone through the SLIC (for example by applying a voltage to ring the phone). It generates tones such as busy and ring-back, and detects touch-tones from the handset, converting them to logical notifications (using a protocol such as IETF RFC 2833).

To initiate calls over the IP network to a remote endpoint, the IP-DSTB uses a signaling (call control) protocol such as SIP, H.323 or MGCP. When the call is established with this signaling protocol, the media flows between the endpoints in Real-Time Protocol (RTP) packets.

The RTP packets contain the audio portion of the call in a compressed format. The application compresses and packetizes the media stream from the phone, using a codec such as ITU G.711 or G.729, and transmits it over the IP network in RTP packets.

Depending on the application software, the following telephony features may be available:

- Caller ID
- Dual Tone Multi Frequency (DTMF) Dial Tone
- Call Hold
- Call Transfer
- Call Waiting
- Call Forward
- Microphone Mute
- Incoming Call Screening
- Volume Change
- Set Custom Ring Tone
- Missing Call
- Speed Dial.

Figure 6 is an example of a generalized system block diagram for VoIP.

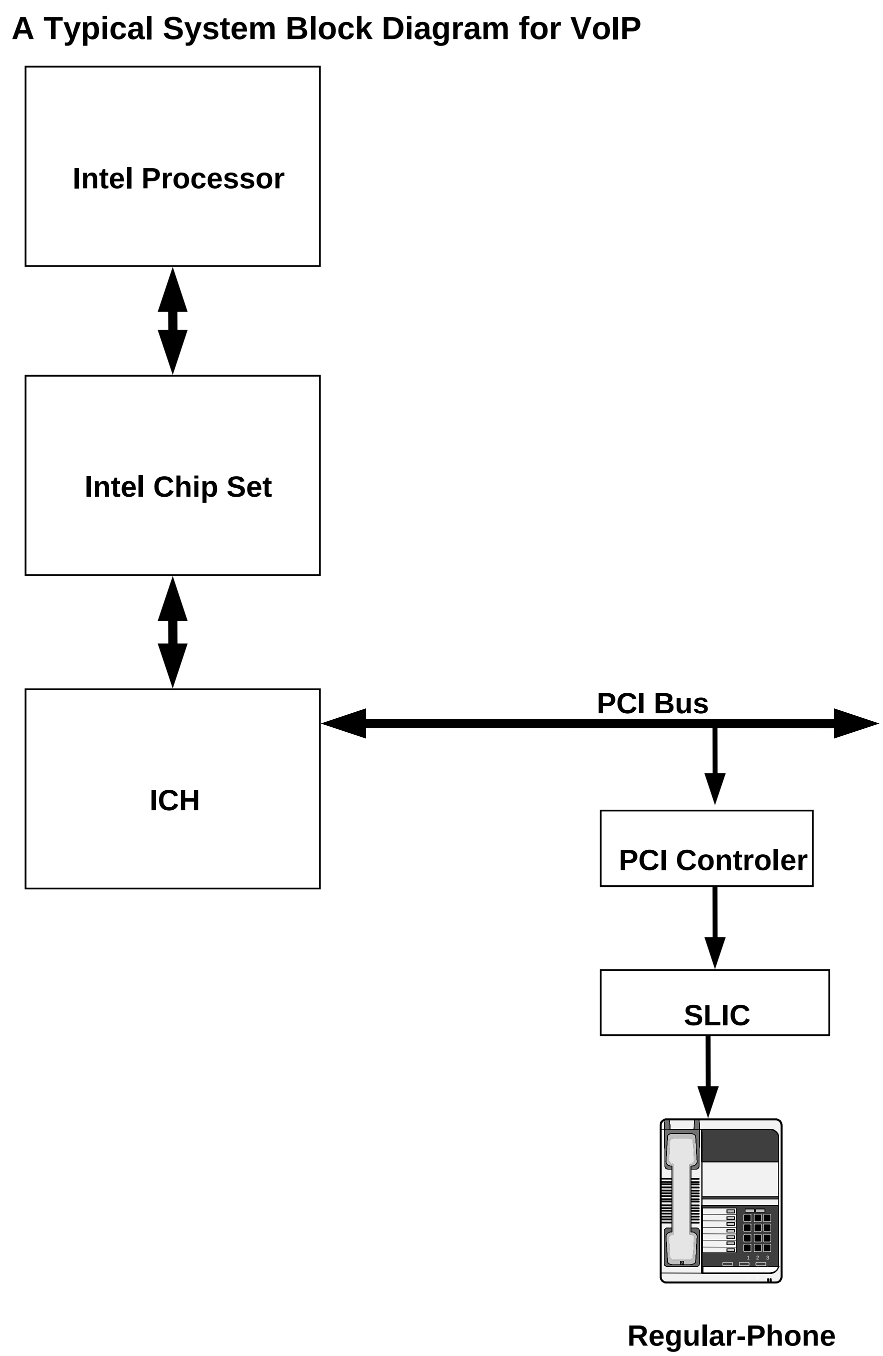


Figure 6. System Block Diagram for VoIP

Figure 7 shows the signal protocols layer of Windows CE for VoIP.

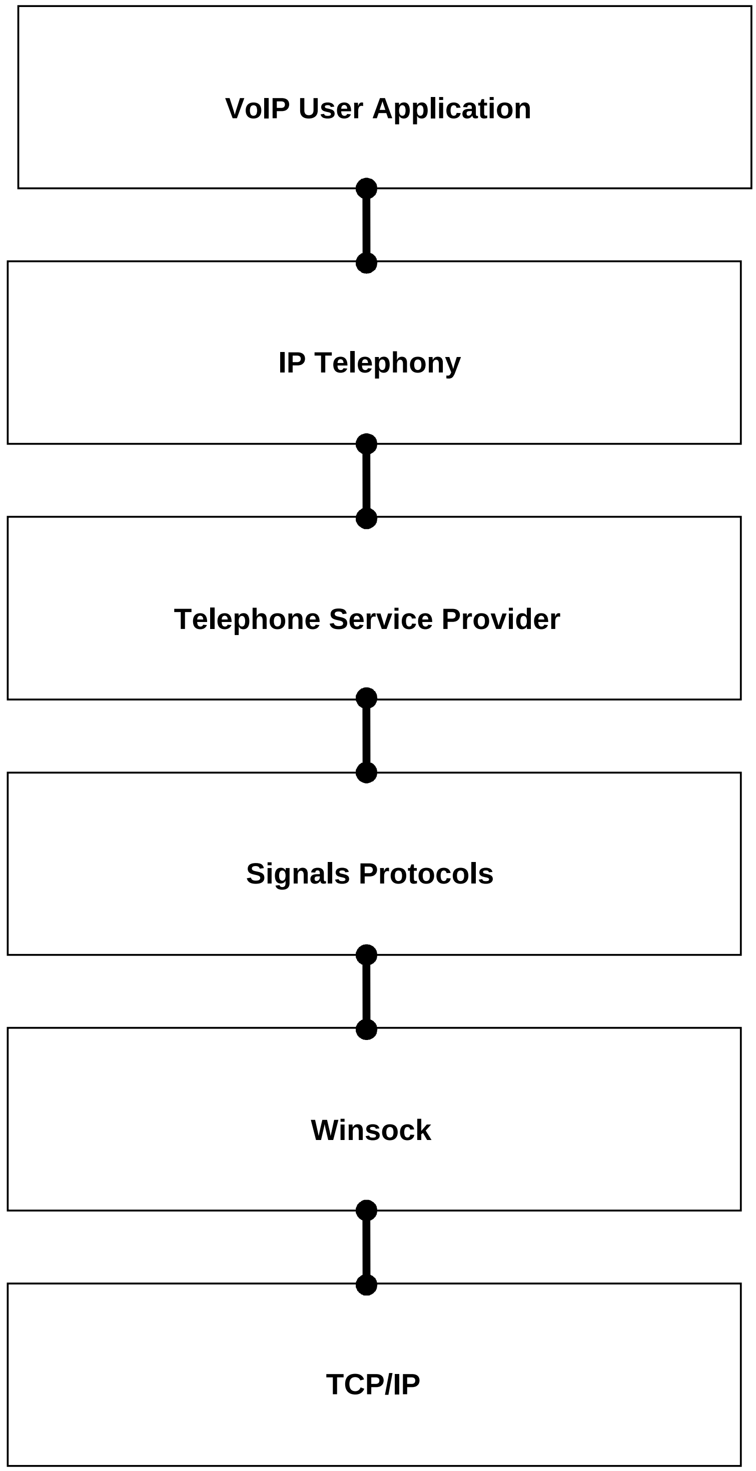


Figure 7. Signal Protocols Layer of Windows* CE for VoIP

3.3 VoD over IP

3.3.1 Solution Architecture and Technologies

IP Video on demand (VoD) provides a compelling set of usage models for consumers and can create significant revenue opportunities for network operators and service providers. A VoD over IP solution includes four core elements:

- A high-speed access network
- Head end equipment
- Customer premises equipment
- Middleware

Figure 8 illustrates the functional blocks of VoD over IP.

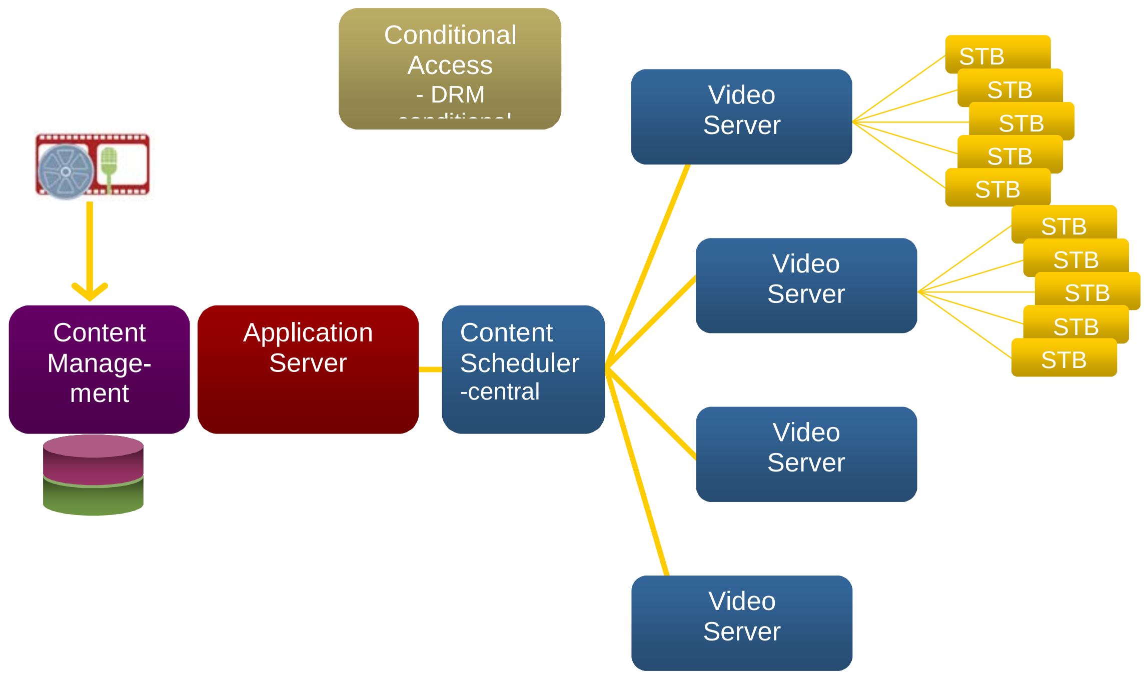


Figure 8. VoD Over IP Functional Blocks

VoD solutions are based on several key technologies:

- **Encoding** – Including the processes, equipment, features and management associated with the digitization and ingestion of video assets into the appropriate digital format, profile, resolution and sound configuration for distribution and consumption.
- **Video Streaming** – Transport of video over IP using a streaming format such as MPEG-2, MPEG-4, MEG-4.10, or VC1.
- **Content Distribution** – Pushing video content to edge servers so as to avoid bottlenecks and allow scalability and improved response times.
- **Digital Rights Management** – Ensuring content and rights protection through a combination of encryption, licensing, and conditional access technologies.

- **Middleware** – Including specialized applications to enable the creation, management, and presentation of VoD services. This software resides at the network head-end and on the IP set-top-box. The middleware must interact with video streaming servers, as well as legacy billing and customer management systems.
- **IP Set Top Box** – Providing the interactive content gateway that is required to receive broadcast digital television, as well as providing the consumer with navigation capabilities for accessing, selecting, and viewing live or on-demand video using a PC or the TV.
- **Management** – Incorporating proactive monitoring, management and reporting of fault, performance and network service for maximum efficiency and uptime.

3.3.2 The VoD Software Ecosystem

Intel is working with several companies to validate their solutions on Intel Architecture IP-DSTBs. There are companies serving some of the segments of the VoD ecosystem. Combining the performance and flexibility of Intel IP-DSTB platforms with the ability to mix and match third-party solutions provides VoD application vendors with best-of-breed solutions capable of expanding to support additional services as markets evolve. Appendix A lists additional IP-DSTB/DMR vendors.

3.4 Trickle Charge VoD

Using the Intel Architecture platform to provide PVR functionality enables a service provider to utilize the hard disk drive to store hours of content. The trickle VoD approach provides a means of delivering content to the user in a push method, which is typically controlled by the service provider. This VoD service is a non real-time solution, where the service provider pushes the content in the background over a period of time. Since this content is intended to be viewed off-line, there is no need to stream the content.

The Intel® 854 development platform provides several components that support the PVR requirements. The addition of an 80 GB hard disk drive (HDD) enables the storage of approximately 200 hours of video content. The processing headroom available with this Intel Architecture chipset enables the set top box to simultaneously display a digital video signal coming through a DTV tuner, while downloading a video file using an Internet service. The downloaded video file is received through the Ethernet controller or PCI interface and routed through the ICH to the IDE bus and stored onto the HDD.

Implementing this type of product on an Intel 854 based system also provides a platform for flexible and robust real-time operating systems with application layers built to provide encryption and storage management of content delivered via trickle VoD or other VoD methods. Trickle VoD maximizes the use of the Intel Architecture by utilizing alternate components or bandwidth while the end users enjoy viewing their current broadcast or content.

3.5 Electronic Programming Guides (EPG)

Viewing live content anytime and anywhere in the home presents a unique set of challenges. Today’s EPGs reflect service provider programming that is specific to the tuning mechanism and user presentation of the set top box. In order to provide seamless live content selection in the digital home, a standards-based solution for content description is required. By working with the

UPnP Forum* Scheduled Recording Service (SRS) Working Committee, Intel has helped create the software and specifications for an interoperable, standards-based EPG. This EPG maps well to popular proprietary guides and still allows for content description within the context of the source tuner and time zones.

Expected in mid-2005, SRS enables devices to know what programming is on at which times in the appropriate time zone, and the specifics for tuning in. Intel plans to integrate SRS into its Digital Media Infrastructure to enable customers to combine and simplify the presentation of programming guides, regardless of its source. This will take the industry another step closer to seamless content sharing while enhancing ease-of-use. Intel processors deliver the performance required for database search and retrieval to support EPG applications.

3.6 Gaming

Gaming is one new application expected to operate on the IP-DSTB or DTV. Platforms based on the Intel 854 GMCH enable service providers to offer interactive multiplayer games as an additional service. The majority of games serviced on the Internet are 2D games. With a new breed of graphics APIs, such as Java* 3D API, emerging for the embedded market segment, service providers can support 3D graphics based gaming through the Intel 854 based platform.

Figure 9 illustrates examples of 2D gaming.

Figure 9. Examples of 2D Gaming

Figure 10 shows examples of entry-level 3D gaming.

Figure 10. Examples of Entry Level 3D Gaming

4 Content Sharing

4.1 Introduction

The digital media revolution is capturing the imagination of consumers. Digital cameras, personal video recorders, MP3 audio players, HDTV displays, IP-digital set top boxes, and new generations of mobile devices and entertainment PCs are just some of the products generating buzz in the world of consumer electronics. This chapter discusses how the growing popularity of home networks and broadband connections is creating new usage models for content sharing within the home, and new opportunities for device manufacturers, application developers and content creators.

4.2 Standards Based Initiatives

4.2.1 DLNA

The Digital Living Network Alliance (DLNA) Home Networked Device Interoperability Guidelines have been created in a cross-industry effort combing input from over 100 companies in Consumer Electronics, PC and mobile industries. These companies have worked together with the aim of achieving the world's first substantial standard for interoperability between personal computers and CE devices and form the basis for digital home ecosystem interoperability. The guidelines define two key device classes: the Digital Media Server (DMS) and Digital Media Player (DMP).

Additional information on the DLNA can be found at: http://www.dlna.org/home

4.2.2 Real Time Transport Protocol (RTP)

RTP is similar to the more familiar HTTP and FTP file transfer protocols, but it is tailored for the special needs of real-time streaming.

Unlike HTTP and FTP, RTP does not download an entire movie to the client device. Instead, it siphons-out a thin, one-way data stream at a constant data rate that plays the broadcast in real time (after a few initial moments of handshaking and data-buffering). A streamed one-minute movie plays in exactly one minute. As long as the connection has enough bandwidth to handle the data stream, the movie will play. After the data is displayed, it is discarded. Viewers can see the broadcast again only by requesting it from the streaming server. Future versions of DMI will include support for RTP Media Device Virtualization as shown in Figure 11

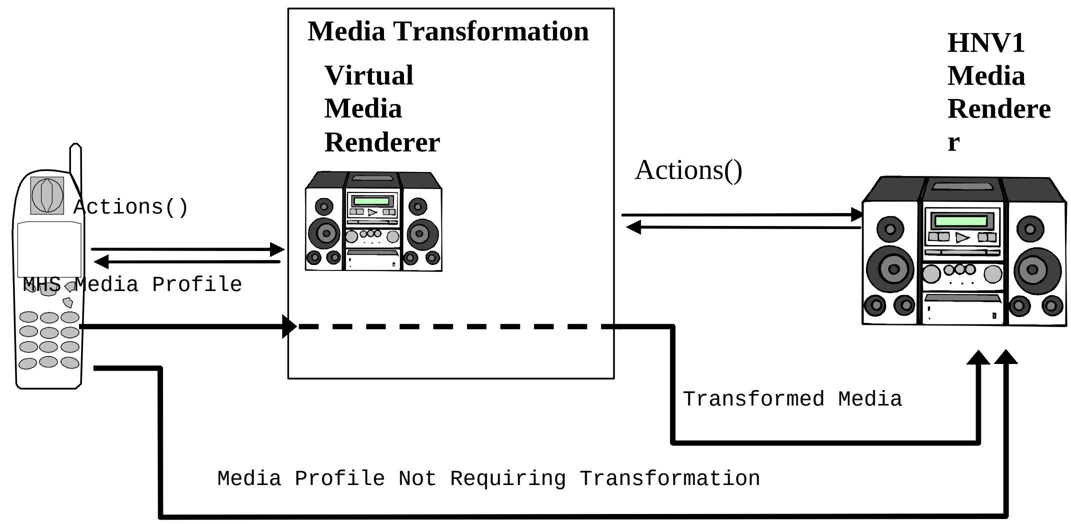


Figure 11. Media Device Virtualization

Home networked devices and mobile or handheld devices have different sets of media requirements. Typically, mobile devices have smaller screens, lower capability processors, less storage, and lower communications bandwidth, and media profiles are tailored accordingly. Media servers in the home may not have content in profiles that are appropriate for the handheld, and renderers within the digital home may not accept the handheld-optimized profiles. In addition, media servers may not be able to interpret bit-streams of content formats that are important to handheld devices, and will not be capable of streaming that content.

In order to increase the interoperability between mobile and home devices, media transformation (as shown in Figure 12) is an important consideration for the interface between handheld devices and the digital home. The network should include a device that accepts media from the handheld device and makes it available in common home networking profiles. Such a solution must accept media from the home network and make it available to the handheld device in a profile appropriate to that environment. Within the DLNA guidelines, media is made available through the use of a Media Server, and consumed through MediaRenderer devices.

4.2.3 Media Transformation

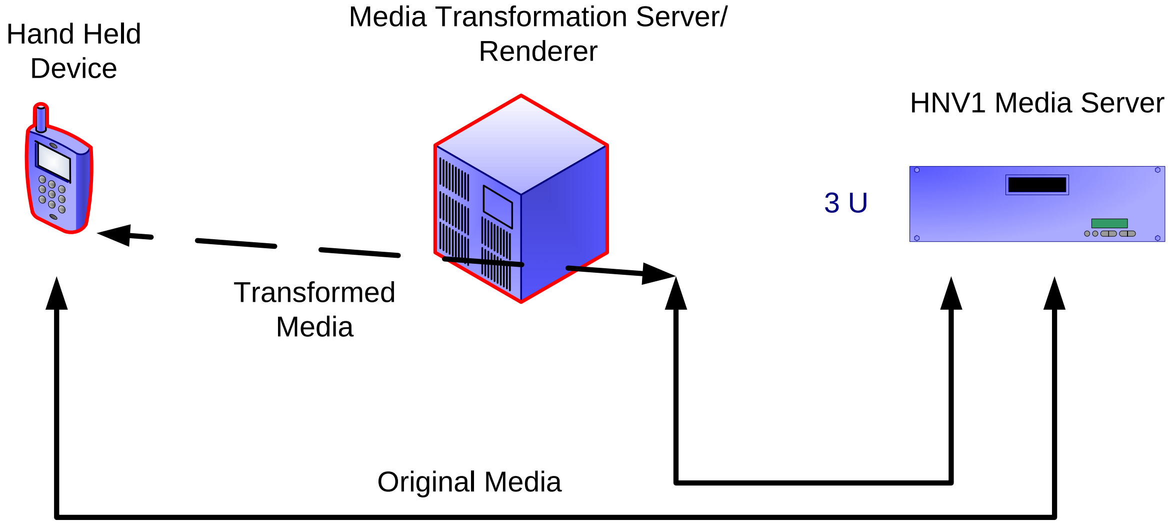


Figure 12. Media Transformation

Media Device virtualization is a DLNA subcommittee working on seamless interaction between a handheld device and the DLNA home network.

DLNA devices and handheld devices have different sets of media requirements. Typically, handheld devices have limitations with their bandwidth, processor capacity, and memory and support different media formats. Media servers in the home may not have content in profiles that are appropriate for the handheld, and Renderers within the digital home may not accept the handheld-optimized profiles.

To facilitate the interaction between mobile and home devices, transformation of media is an important consideration for the interface between handheld devices and the digital home. A device in the home network is needed that meets the following requirements:

- Accepts media from the handheld device
- Makes the media available in profiles
- Is compatible with a SetTop box

This device must also be capable of taking content from the SetTop box and transforming it to a profile so that it is acceptable to the handheld device.

A media transformation server/renderer is a device that abstracts the capabilities of other devices in the network. For example, if there is a server available that has MPEG-2 content, a virtual media server can be created that can serve MPEG-4 content. When a control point requests MPEG-4 content from the virtual server the media is transcoded from MPEG-2 to MPEG-4 and the virtual server uses a control point to drive the real server to actually serve the transcoded MPEG-2 content. A similar action can be performed for media Renderers.

4.2.4 Quality of Service (QoS)

Providing a satisfying entertainment experience for users is crucial to the success of the networked digital home. Different types of network traffic have inherently different sensitivity to delay and jitter. In data networking, issues such as interference and bandwidth fluctuations can be easily managed to make them transparent to an application. In multimedia applications however, such obstacles can impact the user experience. Quality of Service (QoS) is the technique of giving preferential treatment to some packets compared to others, according to their sensitivity to delay and jitter. Enumeration and enforcement of QoS needs to be applied uniformly across the home network. This solution must also be consistent with emerging digital home standards.

UPnP QoS is an Intel-driven initiative that extends the UPnP framework to enable uniform set-up and enforcement of QoS, defining a control protocol that spans across various network technologies, platforms, and implementations and enables consistent application of QoS Policy across the home network, independent of underlying link-layer QoS technologies. In addition, Pump QoS defines the discovery and description of QoS capabilities and available resources of the network.

End-to-end admission control (both start-up and runtime), traffic stream enumeration, enforcement of user defined QoS Policy and topology detection are currently covered in UPnP QoS scope. UPnP QoS version 1.0 specification is complete, and is expected to be ratified later this year. Intel’s Consumer Electronics Group has a complete reference implementation (over wireless) that demonstrates the value of UPnP QoS.

4.2.5 Scheduled Recording Service (SRS)

Currently, UPnP does not provide any mechanism to record over the network. There are, however, UPnP services that enable users to Play, Stop, Import media files across the network. The Scheduled Recording Service (SRS) is a UPnP service that allows control points to schedule the recording of content. Generally, this is broadcast content, but the specification does not limit itself to broadcast content. This service type enables the following functions:

- Create a recordSchedule so that it is added to the list of recordSchedules. Each recordSchedule describes user-level recording instruction for the SRS.
- Browse a list of recordSchedules stored by the SRS.
- Delete a recordSchedule so that it is removed from the list of recordSchedules.
- Browse a list of recordTasks, stored by the SRS; the SRS may create zero or more recordTasks for each recordSchedule; a recordTask represents a discrete recording operation of a recordSchedule.
- Update a recordSchedule to change the associated recordTasks.
- Enable or disable individual recordTasks.

A recordSchedule represents the user-level instructions to the SRS. An SRS is normally implemented on a PVR or on any device with recording capability. An SRS implementation has a single, flat list of recordSchedules. These user-level instructions have various levels of complexity. For example, a simple instruction may “record channel 15 at 4:00 PM on March 19, 2005,” while a more complex instruction may “record all episodes of the “*DIY Home Improvement Show*” on any channel that has the show for the next month.”

Such behavior of a recordSchedule is depicted by one or more properties, and these properties can be manipulated through several actions. When a control point requests a new scheduled recording

to SRS, the control point sets a number of properties and passes them to the SRS in order to inform user desired instruction to the scheduled recording. Then SRS returns a recordSchedule as a response of the request in order to indicate accepted settings. Figure 13 illustrates the structure of the SRS.

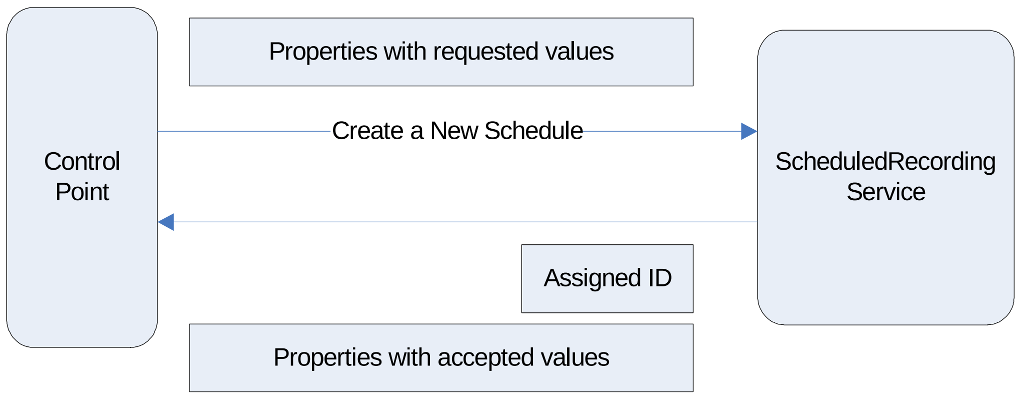


Figure 13. Structure of SRS

Table 3 lists the various types of RecordSchedules.

Table 3. Types of RecordSchedules

Class	Description
manual	Represents user-level instructions in terms of exact scheduling parameters. Most often, the properties included in this type of a **recordSchedule** include the date and time, recording duration, and input/channel to specify the program to be recorded.
programID	Represents user-level instructions in terms of a content identifier. This type of a **recordSchedule** often requires the underlying recording system to interact with a broadcaster-supported information system that identifies content using a unique program identifier, usually a number.
programTitle	Represents user-level instructions in terms of the content's title. This type of a **recordSchedule** often requires the underlying recording system to have access to an EPG metadata.
programCode	Represents user-level instructions in terms of program codes provided by various program guide services. A property included in this type of a **recordSchedule** defines a type of a program code that specifies the program to be recorded.
cdsObjectID	Represents user-level instructions where the control point specifies the **@id** value of a CDS object of a CDS that is co-located with the SRS. This type of **recordSchedule** often requires the underlying recording system to have access to an EPG metadata, such that the CDS can present the EPG metadata to a user via a control point.

4.2.6 Intel NMPR v2.0

The Intel Networked Media Product Requirements (Intel NMPR) v2.0 references the DLNA guidelines and provides additional implementation guidelines that may enhance the consumer

experience when a PC, set-top box (STB) or other computing device is available on the home network. Intel NMPR v2.0 extends device capabilities in several ways. It strengthens or extends some DLNA guidelines for increased robustness, specifies additional optional formats and introduces additional capabilities not in the scope of the DLNA guidelines, such as UPnP Remote User Interface (RUI) and DTCP-IP for premium content.

DMI 3.0 will be NMPR v2.0 complaint. Some of the key features of Intel NMPR v2.0, like RUI and DTCP/IP will make the digital home software stack even more robust.

4.2.7 UPnP Remote I/O

In a typical home, different family members have preferred devices they use to communicate with the digital services available in the home. Parents might prefer to use the television in the bedroom, and children may prefer their mobile phones or mobile game consoles. The digital home interoperability stack should have a user interface that fits these different devices. Dealing with user interfaces in a multi-service model is a complex issue. Services must be tailored to devices ranging from high-end televisions to mobile phones, each with different screen sizes, graphics capabilities, CPU power and available bandwidth. In addition, one can observe a trend towards more interactive and mobile services. Figure 14 shows the interaction of UPnP remote I/O.

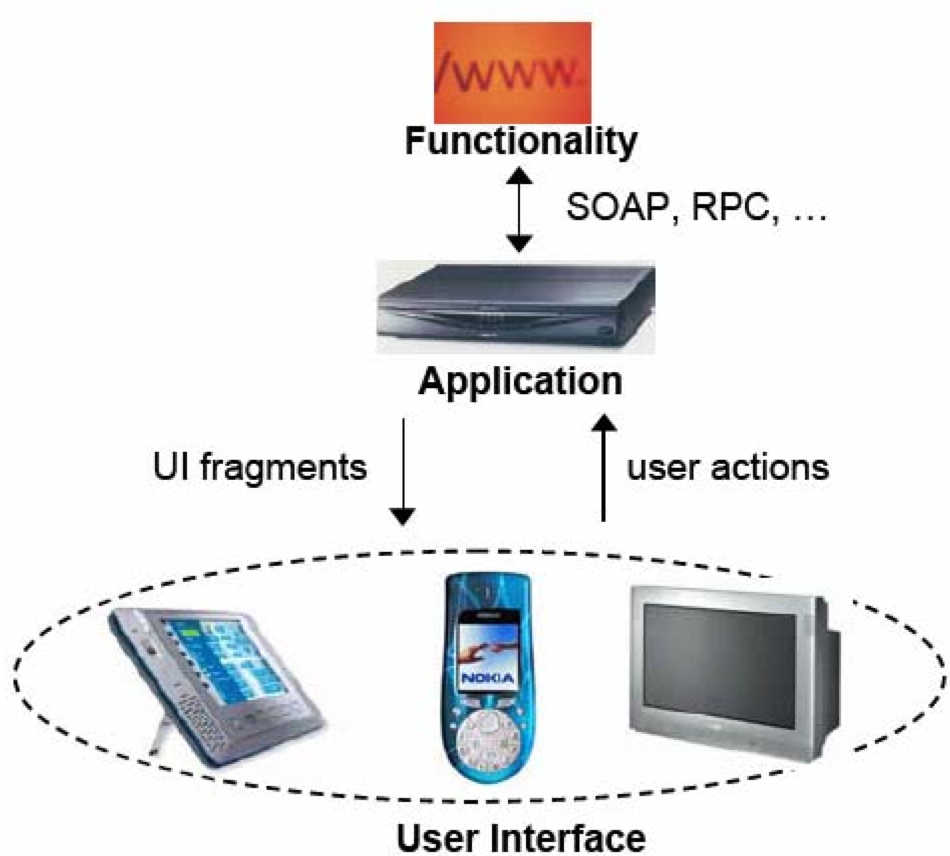


Figure 14. UPnP Remote I/O

A possible solution to address the problem of user interfaces in a multi-device environment is the RUI protocol. The protocol focuses on device interdependence in order to support user interfaces on a variety of devices (for example, TV, PC, or mobile phone). This interdependence is achieved through the following mechanisms:

- **Abstract UI Definition**: a set of widgets, selected from the commonalities between different kind of user interfaces, make up an abstract user interface definition including: container, list, range, entry, button, progress, text, and image.
- **Device Capability Description**: a multi-level style sheet provides the client device with hints on how to render the widgets onto the screen. Because general information is put higher inside the style hierarchy, style information from a multi-level style sheet can easily be reused on a variety of devices. Furthermore, it relieves the application developer from a huge authoring effort that would be required when designing style sheets for all targeted devices.
- **Widget Priorities**: a client device that does not have enough space available to display all widgets can decide, on the basis of the widget's priority, not to show the widget. For example, if the user interface has a "Mute"-button and a "Volume"-range, the "Mute"-button can be given a lower priority, because the "Volume"-range already exposes the functionality of the "Mute"-button.

The remote user interface protocol is designed to address the requirements for next-generation networked applications (see Figure 14). The typical behavior for the client, which is rendering the user interface, and service application, is as follows:

- The client discovers the service application.
- The client subscribes to the service application. In return, the client receives the initial user interface description.
- User actions on the client device are forwarded to the service application, which sends an action result, describing the changes in the user interface, as response.
- The service application can send a server result when it wants to notify the client of user interface changes.
- When the client or application service want to terminate communication an appropriate message is sent.

By exploiting UPnP, discovery, controlling and subscribing to remote user interface services can be simplified using the available architecture. This can be done by introducing RUI service templates for UPnP, which describe the services for clients (UISink) and servers (UISource). The messages sent from the service application to the client device contain XML-based user interface descriptions, so-called "UI fragments." These are processed by a thin presentation engine on the client and presented to the user. These fragments contain the initial user interface and the changes to the user interface in terms of the widgets defined[1].

4.2.8 DTCP/IP

Many peer-to-peer content sharing applications exist that allow content to be shared between computers on a home network. UPnP allows content to be easily and seamlessly shared among computers on a home or private network. This scheme works well for personal content (such as home movies or digital pictures), but is not adequate to safeguard premium content, such as Hollywood movies, from illegal duplication.

The primary concern with content sharing is the protection of premium content that is digitally distributed on a home network. The issue is how to enable the distribution/sharing of legally

purchased or recorded digital content, while preventing illegal duplication of the premium digital content. To solve this issue, Intel, Sony, Hitachi, Toshiba and Matsushita participated in the development of the Digital Transmission Content Protection over Internet Protocol specification (DTCP over IP, DTCP-IP), a specification for copy protection of copyrighted content that is transferred over digital interfaces in home IP networks. DTCP is sometimes called the "5C Specification" because it was developed by the five companies. DTCP is licensed to manufacturers by an organization known as the Digital Transmission Licensing Administrator, or DTLA. Early versions of DTCP were implemented for content transmission over consumer digital interfaces such as IEEE-1394a and USB, but it is now being implemented for other digital interfaces including Ethernet.

Under the DTCP-IP specification, digital content can be shared securely between devices in a user's home, but not shared with third-parties outside the home network. Using an authentication scheme, DTCP-IP designates devices in the home network as trusted clients that can receive and/or transmit data within the home/private network. DTCP-IP will not allow the content to be transmitted over the Internet to be shared outside of the home network. DTCP has four layers of copy protection:

- Copy control information (CCI). Content owners need a way to specify how their content can be used ("copy-one-generation", "copy-never,").
- Device authentication and key exchange (AKE). Before sharing valuable information, a connected device must first verify that another connected device is authentic. There are two authentication levels: Full Authentication (can be used with all content protected by the system) and Restricted Authentication (enables the protection of "copy-one-generation" and "no-more-copies" content only).
- Content encryption. Devices include a channel cipher subsystem that encrypts and decrypts copyrighted content. To ensure interoperability, all devices must support the specific cipher specified as the baseline cipher. The subsystem can also support additional ciphers, whose use is negotiated during authentication.
- System renewability. Devices that support Full Authentication can receive and process system renewability messages that ensure long-term integrity of the system.

DTCP provides system renewability as well as an encrypted exchange of content and CCI between authenticated devices. To date, DTCP has been defined and licensed for use in protecting the transmission of content via the IEEE-1394 serial bus (1394), the Universal Serial Bus (USB), and the Media Oriented Systems Transport (MOST), which is commonly used in the automotive sector.

DTCP-IP specifies security technologies that are implemented on the networked computers, as well as the content itself. Under the specifications of DTCP-IP, each computer on the network is authenticated with a security level that determines its ability to playback and/or copy shared digital content. In addition, all content is encoded with security levels that determine how often the content may be duplicated (that is, never, copy once, copy many times).

Before premium content can be shared across a digital interface, the sending and receiving (or "source" and "sink") devices must first perform a joint authentication procedure. Authentication consists of a sequence of data swaps and key calculations that validate the licenses of both devices.

Compliant devices determine which access and copying activities are legal by examining two bits of Copy Control Information (CCI) transmitted with each packet of protected content. These bits can define four possible copy-protection states:

- "Copy freely" (CCI=00)
- "No more copies" (CCI=01, which specifies that the content is a first-generation recording that cannot be copied again).
- "Copy one generation" (CCI=10)
- "Copy never" (CCI=11, for original content that cannot be copied)

Every DTCP-licensed device must store a Device Certificate that contains a variety of keys and identifiers issued by the DTLA. This Certificate is a complex data structure, and its exact format depends in part on whether the device supports Full or Restricted Authentication. Full Authentication is required to transfer content marked as "copy never" and is optional for other types of content. All DTCP-compliant devices support Restricted Authentication, but this is likely to be the sole option available to components that merely copy data, such as writable DVD drives, DV recorders, and digital VCRs. Only devices with more robust computing capabilities, such as personal computers, can perform a Full Authentication.

Once two compliant devices have authenticated each other's right to perform protected transfers, they assemble the appropriate encryption/decryption keys and set up a secure path. Content is then encrypted sector-by-sector, using one or more authorized cryptographic ciphers. The sender and receiver decide on which ciphers to use during the authentication process, but they must always employ the M6 Cipher, which was originally developed by Hitachi and is similar to algorithms used to encrypt Japanese digital-satellite broadcasts. M6 provides high-security strong encryption and is classified as a common-key block cipher algorithm based on permutation-substitution techniques. DTCP-compliant devices can also increase security by adding algorithms like the Data Encryption Standard (DES) and the Modified Blowfish Cipher. The source forwards CCI along with the data stream, and the downstream device uses this information to decide whether to honor requests to copy the content.

DTCP also provides a system renewability feature that allows the DTLA to prevent unauthorized devices from intercepting protected data streams. Every compliant piece of equipment stores a DTLA-generated System Renewability Message (SRM) that lists devices that are no longer licensed or that are known to be used for illegal duplication. This list is checked during the authentication process and if a source determines that it is communicating with an illegal device, it will refuse to send it data.

Every compliant device stores the same SRM, which is periodically updated and distributed by the DTLA. The most common method of distribution is to embed the updated SRM into all new DTCP-protected content. Devices will then automatically load the revised SRM from prerecorded DVDs, download it from digital cable or DBS satellite broadcasts, or receive it from attached devices that have already been updated.

The Digital Transmission Licensing Administrator allows only its licensees to know the full implementation details of DTCP. The DTLA provides a white paper and an Informational Specification that can be downloaded from the DTCP Web site http://www.dtcp.com. These documents provide a more thorough description of the data structures and cryptographic functions specified by DTCP for content sharing.

In addition, when sharing content between computers on a network, issues related to formats, CODEC and bit-rate must be comprehended. The sharing application should determine what format the content is stored in, and whether the receiving computer has the necessary CODECs to decode the content. Also, depending on the performance capabilities of the receiving computer,

transcoding and/or transrating may be used to vary the compression and/or bit rate of the content being shared.

4.2.9 Trick Modes

Consumers now expect trick playback functionality from digital media much in the same way as they are used to in analog recording or playback devices, such as a VCR. This includes classic trick mode operations such as fast forward/reverse and slow motion. In general playback, trick mode is defined as operations that require random access into the formatted media (being analog or digital) including all types of content navigation.

Fortunately, most digital media not only is adept to or enhances the classic trick playback modes but it enables use cases that were previously impossible in analog media. One example is instant resume or chapter navigation.

There are many system and platform challenges that must be overcome in order to enable trick mode playback in a digital system. Some of these include:

- Forward and backward dependencies in video frames encoded using standards based compression algorithms
- Limited platform capacity for local buffering and caching, especially thin clients with low system memory requirements and no hard disk media
- Bandwidth optimization in a network streaming environment.

4.2.10 Home Networking Software

4.2.10.1 Software Stack Overview

Figure 15 illustrates the Intel Consumer Electronics Group home network software framework, including DMI that supports DTSB, DMR, and DMS implementations that are conformant to the DLNA HNV1 interoperability standard.

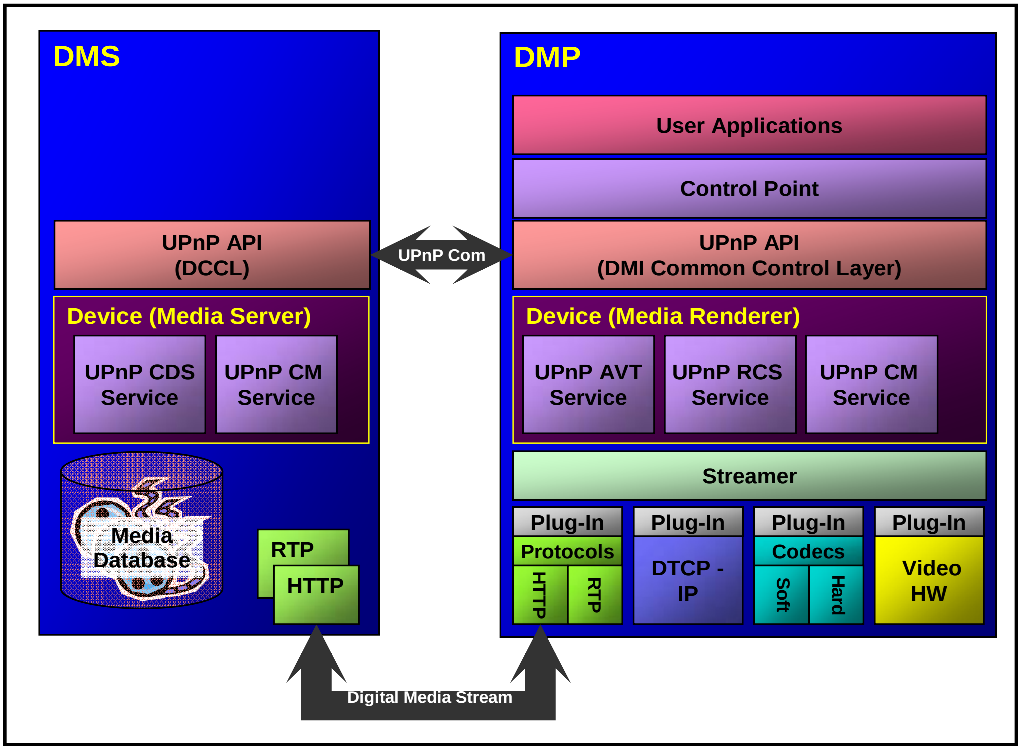


Figure 15. Home Networking Software Framework

4.2.10.2 DMI Overview

Intel's DMI is based on the UPnP frame work. UPnP framework defines the following software components implemented on various devices in a distributed fashion.

- Media Server
- Control Point
- Media Renderer

Media Server functionality provides access to media data. Control Point allows a user to discover and control other devices and the data flow between devices. Media Renderer function allows playback of a variety of rich media formats on a device. Devices with Media Server functionality are used in conjunction with one or more Media Renderer device(s).

In a typical UPnP session, a Control Point uses SSDP (UPnP discovery service) to discover audio/video (AV) entertainment content such as video, music, or images on one or more Media Servers. The Control Point also uses the same SSDP service to discover Media Renderers on a home network. Then, a user activates Control Point features (using source unit buttons or an IR remote control) to browse or search within a Media Server to locate a desired piece of content (for example, a movie, song, play list, or photo album). The Control Point then prepares to render that

content on a device with an appropriate Media Renderer. After the desired content has been identified, the Control Point determines an appropriate transfer protocol and data format to transfer the content from the Media Server to the Media Renderer. Transfer protocol examples include IEEE-1394a, HTTP GET, and RTSP/RTP. Data format examples include MPEG-2, MPEG-4, MP3, WMA, and JPEG.

After these transfer parameters have been established, Control Point controls the flow of the content such as Play, Pause, Stop, or Seek. The actual transfer of content is performed directly by the Media Server and Media Renderer. The content transfer occurs independently from the Control Point, and does not involve UPnP specifications. In fact, UPnP specifications indicate that transfer protocols are not within the domain of UPnP. Control Point uses UPnP to set up transfer of the content, but the transfer is performed using a transfer protocol other than UPnP.

Content Directory Service

Control Points use a Media Server's Content Directory service to locate desired content. The Content Directory service exposes both a search capability and a browse capability. Searching is useful when the Control Point through the involvement of the end-user, knows something about the content it wants to find such as the name, artist, type, or date created. Browsing is useful for blindly discovering content that a device has to offer. Each content item that is referenced by the Content Directory service includes information about that content, including transfer protocol(s) and file formats that the Media Server can use to transfer the content to a Media Renderer.

The DMI implementation of this service abstracts the database mechanism that stores content metadata thereby allowing implementers to choose a database engine that suits their particular needs. This design also enables implementers to easily extend this service to include innovative new functionality.

Connection Manager Service

The Connection Manager Service allows a Control Point to establish a connection between a Media Server and Media Renderer, to monitor all connections, and to terminate a connection.

AV Transport Service

AV Transport service enables control over the transport of audio and video streams. This service defines a common model for A/V transport control suitable for a generic user interface. It can be used to control a wide variety of disc, tape, and solid-state based media devices such as CD players, VCRs and MP3 players. It allows a Control Point to issue audio/video functions such as play, stop, or shuffle.

Rendering Control Service

The Rendering Control Service (RCS) provides an interface that allows the rendering device to be adjusted in its operational parameters. This service will for example allow a user to adjust the red tint on his TV screen.

4.2.10.3 Advanced features

The future development of DMI is being driven by two major initiatives: standards and customer-driven initiatives. Key standards are being developed in the home networking space, including DLNA and Intel NMPR v2.0. DMI will comply with all of these standards.

Some features are not being covered by any of these standards and are being specifically requested by customers, including network-wide content management, DRM, and wireless streaming. DMI will prioritize these features and will ultimately incorporate them.

To date Intel has provided two releases of DMI: DMI v1.0 and DMI v2.0. DMI v1.0 is conformant to Intel NMPR v1.0 compliant. DMI v2.0 is being targeted for release in late 2004 and is DLNA 1.0 compliant.

4.2.11 Content Management

Content management is the ability of devices in the home media network to locate devices on the network that store media, interrogate these devices about the characteristics of that media and finally make decisions based on the results of that interrogation. This involves finding media in which the end-user is interested and then determining if the desired media is available in a format consistent with the rendering device that is to be used. Content management information within the UPnP A/V framework is metadata that is stored in the Digital Media Server (DMS) along with the content itself in the form of XML language elements.

The design of the DMS device within the DMI suite takes a generalized and abstracted approach to the creation, storage and retrieval of metadata. All metadata are stored via a database engine within the DMS device. Metadata that are general in nature (such as the title of a movie) are represented in the database only once no matter how many differing formats such as MPEG-2, VC1 (Windows Media Video 9 profile will mostly likely be adopted for CE), or MPEG-4, that the content may have. This simple approach is possible because the associations between metadata elements are completely flexible because they are described abstractly through database relations. Associations between metadata and the actual content are made only when necessary and appropriate. Adding a new type of metadata simply means adding to existing database tables to reflect the desired relation in the schema of the metadata database.

4.2.12 Allocating Network Resources (Policies and Resources)

The digital home promises to personalize the home entertainment experience by making content available to users anytime, anywhere. Consumers demand reliable and consistent performance from their entertainment devices. While consumers may tolerate performance degradation on a loaded PC, such tolerance will not be extended to watching a networked DVD. This consumer demand for reliable and consistent entertainment performance requires management of the availability of serially reusable resources including tuners, hardware signal processors, and processing power. In turn, allocating resources to specific networked media streams requires that we have an effective mechanism for dealing with conflicts.

Intel Consumer Electronics Group is developing flexible policy management mechanisms that can be easily tailored for specific products. The Device Availability module tracks the current and future availability of serially re-usable resources. Using DA, applications can quickly determine resource availability and make future reservations. DA deals with details including mutually exclusive access to device calendars, safeguarding reservations across power events, and normalizing schedules across time zones.

The Policy Store captures the conflict resolution rules associated with limited available devices. The policy store is capable of basing rules on a number of predefined variables including time, the requesting device and content description. In addition, applications may define their own vectors

along which to manage device access. The result is an extremely capable and flexible mechanism for expressing everything from simple autonomous rules to the multi-layered, usage-dependant rule suites. The actual storage mechanism for policy rules is hidden behind an abstract interface allowing adopters to choose the most suitable approach for their device.

The Policy Editor is an engine designed to create rules for addition to the Policy Store. It provides a programmatic API to retrieve, modify, add and delete rules from the Policy store. Primitive but powerful, the Policy Editor is equally capable of supporting simple DMAs with canned policies to the most sophisticated PC-based rule management applications.

4.3 Emerging Services

4.3.1 Digital Rights Management

The DMI stack provides a modular DTCP-IP plug-in, tested and found to be compliant using a Test CA. When you include this plug-in into your software, and program the keys into a suitable read-only device within the box, DMI will be capable of doing encrypt/decrypt on the DMS and DMP.

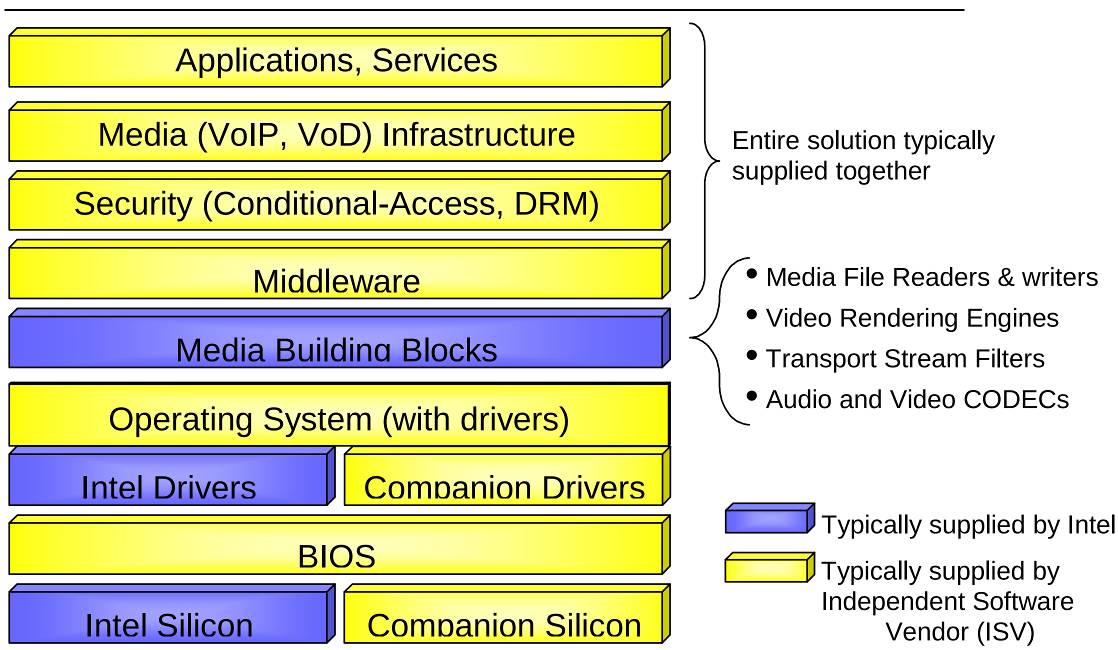
Often, Digital Rights Management is thought to be synonymous with Conditional Access, but effective DRM requires more, for instance, there is a great amount of premium content that is not conditionally-accessed and DRM must consider the end-to-end solution, i.e. how does the service provider specify the LAN content protection rights to be used once the data is brought into the home. Understanding how to set the copy-protection state within DTCP/IP in order to appropriately control distribution on the home LAN is an important consideration.)

Developers should also take proactive steps to counter concerns around content vulnerability, and crypto-engine vulnerability, at various stages of the software stack.

5 Software Building Blocks

5.1 Introduction

IP-DSTBs and DMRs are essential to making tomorrow's digital home usage models a reality. Both platform types are based on platform configurations that include Intel® processors and chipsets. These CE platforms have the performance to run third-party software components including applications, CODECs, middleware and operating systems. Together, the hardware and software building blocks can be used to meet the requirements of emerging consumer usage models, see Figure 16.



Note: The Intel DMI software stack provides inter-operability and some security components.

Figure 16. ISV CE Software Stack Structure Example

5.2 Board Support Packages

Intel offers Board Support Packages (BSPs) for Windows* CE and Linux for many platforms. The performance and capabilities of each operating system implementation has been tuned for the particular configuration selected.

5.3 Operating Systems

Much like the operating system on a PC, the operating system for a set-top box or DMR platform manages how various hardware capabilities of the platform are accessed by the applications and services being provided by the operator. At the core of the embedded operating system, the kernel will manage memory utilization, I/O functions, and multi-task sequencing. The device manufacturer typically makes the choice of embedded operating system as part of the development cycle and will build the operational software and drivers for the basic device functionality around the embedded operating system. The manufacturer will typically license the embedded operating system from the provider, the cost of which is usually absorbed into the bill-of-materials cost of the platform.

5.4 Multimedia Building Blocks

Residing on top of the embedded operating system and platform drivers is a set of building blocks to perform specific functions, such as audio/video stream decoding. These building blocks also provide a framework for high-level applications and middleware, such as a Java virtual machine (JVM), embedded browser, Electronic Programming Guide (EPG) and Graphical User Interface (GUI).

The term CODEC stands for COder/DECoder. Examples of CODECs include audio/video encoders, audio/video decoders, file format readers, audio/video demultiplexers and other filters and translators. As the DMR platform receives the IP stream, the CODEC decodes the stream for display on the TV, supporting such codec technologies as VC1, MPEG-2 and MPEG-4 standards.

Because Intel Architecture can deliver significant processing performance, software-based CODECs can help reduce bill of material (BOM) costs for their DMR platforms. Depending on the needs of the manufacturer, the CODEC provider can deploy the software in a variety of ways, including being part of a media framework provided on a particular operating system, or as part of a software development kit (SDK) that allows for easy integration.

Increasingly, a number of applications and middleware developers are looking for ease in porting and interoperability of their software to various CE devices. ISVs often design their applications in either Java, or as an application that can run within an embedded browser. To support this software structure, a number of third party software companies have optimized and deployed JVMs and embedded browser technology that run on Intel Architecture-based CE platforms.

5.5 Retail Consumer Electronics Middleware

As the digital home becomes increasingly connected, retail consumer electronics middleware providers becomes the “glue” that provides solutions to share, display and manage content seamlessly between consumer electronics devices and PCs. These solutions are deployed on a variety of digital home consumer electronics devices, including media servers, digital media adapters, digital TVs, and DMRs. This software will allow the consumer to display, organize and manage digital photos, music, video and other content shared amongst CE devices in the home, including the ability to “virtualize” the storage and retrieval of digital content in the home regardless of which device the content actually resides on. The software will often also integrate

browser capability that can be further customized by the service provider or multimedia infrastructure provider into walled gardens presented as part of the IP service to the home.

Intel is actively working with a number of ISVs that provide solutions to enhance interoperability through UPnP, as well as, the DMI specifications.

5.6 Service Provider Middleware

IP Digital Set Top Box development is driven primarily by service provider requirements and consumer demand for new features. In its basic configuration, the IP-DSTB simply needs to decode and render broadcast TV signals. For advanced configurations, an IP-DSTB can include a variety of multimedia-on-demand capabilities and services, digital rights management (DRM) and interactive in-demand features like home networking, Web browsing and real-time voice over IP (VoIP). The software that manages the delivery and service of these capabilities, as well as the core operating system for the set top box, is provided by key external software vendors with whom Intel works closely to ensure interoperability and optimization to the platform architecture.

5.7 Security and Conditional Access

A critical part of streaming premium digital content is the ability to provide protection against piracy and ensuring that the content is viewed only by the audience for whom it was intended. Security and conditional access software will use algorithms to encrypt and scramble content at the head-end, which is then decoded at the set-top box for playback.

5.8 Multimedia Infrastructure Providers (VoIP/VoD)

The deployment of IP-DSTBs and the associated services are typically driven through the interaction of the service provider and a multimedia infrastructure provider. In deploying the full solution, the multimedia infrastructure provider will act as an aggregator delivering the client playback stack, encoding solution DRM scheme, provisioning and content management systems to create, encode, package, deliver, as well as manage the multimedia content. Often the multimedia infrastructure provider will collaborate with other ISVs that specialize in DRM and Conditional Access, and/or middleware to provide an optimized, end-to-end solution to the operator.

5.9 Applications/Services

Over the next few years, consumers can anticipate advances that will enrich their experience in the digital home: Video on Demand (VoD), Voice over IP (VoIP), online gaming, educational content, health-related services and interactive digital TV are just a few of the possibilities. Consumers will be able to access a broad spectrum of “Triple Play” (digital video, voice and data) or “Quad Play” (digital video, voice, data and online gaming) services in their homes over networked CE devices, entertainment PCs and mobile clients. Ultimately, consumers will be able to use an IP-DSTB to deliver content to a variety of CE devices from almost anywhere in the home.

6 Product Implementation

6.1 Introduction

This chapter provides an overview and summary of technology enhancements that will be available for use in 2005 IP-DSTB and Digital Media Recorder (DMR) platforms.

6.2 Internet Protocol – Digital Set Top Box (IP-DSTB)

6.2.1 Platform Overview

The IP-DSTB allows service providers to deploy video, voice, data services via a broadband pipe, such as a xDSL or cable modem. This device extends the traditional set-top box beyond video-based services enabling the delivery of a bundle of services. IP-DSTBs can also be networked in the digital home to deliver content and services to other connected consumer devices. The following sections provide the Use Model requirements, technology building blocks, and implementation details for Intel Architecture IP-DSTBs.

6.2.2 Usage Model Framework

This section summarizes the key use models necessary to compete in the IP-DSTB market segment. Core usage models are the minimum requirements for platforms built in the 2005 timeframe. Target usage models are enhancements utilizing some of the advanced features in the Intel platform. Emerging usage models are those gaining adoption on high-end platforms, being explored for advanced service models or being researched for feasibility, proof-of-concepts, and other technology showcases. Table 4 summarizes the usage model framework.

Table 4. IP-DSTB Usage Model Framework

	Core	Target	Emerging	Comments
EPG	X			Service provider provisioned
Broadcast TV	X			Service provider provisioned
VoD		X		Service provider provisioned
Trickle VoD		X		Service provider provisioned
Music download/purchase		X		Service provider provisioned
PVR		X		
VoIP		X		Service provider provisioned
Video phone		X		Service provider provisioned
Online gaming		X		Service provider provisioned
Health monitoring			X	Service provider provisioned
Remote education		X		Service provider provisioned
Content sharing		X		
DMA		X		
Home security			X	Service provider provisioned

6.2.3 Technology Implementation

This section describes how to implement the platform features/technologies.

6.2.3.1 Platform Components List

Table 5 provides the platform components list.

Table 5. IP-DSTB Platform Components List

Technology	Features
Processor	Intel® Celeron® M Processor
	400 MHz front side bus
Motherboard	Intel® 854 chipset
	ICH4-M I/O Controller Hub
	PC2100//PC2700 DDR SDRAM
	DVOB/C digital video output via ADD connector
	Two IDE controllers with ATA/100
	Six USB 2.0 ports
	Integrated LAN controller
	AC '97 controller with 6 channel sound
Memory	DDR SDRAM memory down on board or on DIM
Add In Cards	TV encoder (reference RML for 3rd party)
	TV tuner card via PCI (reference RML for 3rd party)
Storage	Support for Disk on Module (DOM)
	DVD-ROM disc drive
Chassis	Consumer Electronics form factor / DSTB chassis
	Integrated voltage regulator on board
Peripherals	IR remote control
	Microphone (for VoIP)
Software	Embedded operating system
	Digital photo editing
	Electronic Programming Guide (EPG)
	Personal Video Recorder

6.2.3.2 Intel Processor

The Intel® 82854 GMCH supports the Intel Celeron® M Processor. The front side bus operating at 400 MHz supports a 64-bit host data bus, with 32-bit addressing. For the optimal thermal solution, the performance of the ULV Intel Celeron M Processor at 600 MHz is the fit for consumer electronics applications.

For additional information, refer to the following:

- Intel Celeron M Processor Datasheet (300302-003): http://www.intel.com/design/mobile/datashts/300302.htm
- Ultra Low Voltage Intel Celeron M Processor at 600 MHz Addendum to the Intel Celeron M Processor Datasheet (301753): http://www.intel.com/design/intarch/datashts/301753.htm
- Intel 854 Platform Design Guide (contact your local Intel representative for this document)
- Intel Consumer Electronics Software Downloads: http://developer.intel.com/design/celect/swd/index.htm

6.2.3.3 System Memory

The system should include support for at least one 128 MB Double Data Rate (DDR) SDRAM memory down for an Intel 854 CE specific implementation.

- Double Data Rate (DDR) SDRAM
- Directly supports one DDR SDRAM channel, 64 bits wide
- Supports 266/333-MHz DDR SDRAM devices with max of two, double-sided DIMM (four rows populated) with unbuffered PC2100/PC2700 DDR SDRAM
- Supports 128-Mbit, 256-Mbit, and 512-Mbit technologies providing maximum capacity of 1 GB with x16 devices and up to 2-GB with high density 512-Mbit technology

Recommended memory configuration depends on the application the system will be running. Systems can be populated with memory down if frequent hardware upgrades are not required. For platform scalability, an additional DIMM slot can be included to provide for memory upgrades to allow flexibility for more memory intensive processing. For conventional consumer electronics applications for video streaming and real-time decoding in an embedded operating system, 128 MB should suffice.

6.2.3.4 I/O Controller Hub (ICH4-M)

The features of the ICH4-M are as follows:

- Integrated IDE Controller
  - Supports Ultra ATA/100/66/33 with independent timing of up to 4 drives, with separate primary and secondary IDE cable connections
- PCI Bus Interface
  - Supports PCI Revision 2.2 Specification at 33 MHz with 133 MB/sec maximum throughput
  - Supports up to six master devices on PCI
- Low Pin Count (LPC) Interface
  - Supports super I/O chips for PS/2 keyboard and mouse support
  - Supports firmware hub to interface with BIOS
- Power Management Logic
  - Supports ACPI-defined power states
  - ACPI power management timer
  - PCI PME# support, SMI# generation
  - All registers readable/restorable for proper resume from 0 V suspend states
- Universal Serial Bus (USB)
  - Includes three UHCI host controllers that support six external ports, including one EHCI High-Speed USB 2.0 port and a host controller that supports all six ports
  - Supports wake-up from sleeping states S1–S5
  - Supports legacy keyboard/mouse software
- Integrated LAN Controller
  - WfM 2.0 and IEEE 802.3 compliant providing 10/100 Mbps Ethernet support
  - Connected via LAN Connect Interface (LCI)
  - Uses Intel LXT972M 82562ET/EM LAN connect components
- SMBus
  - Supports SMBus 2.0 Specification
  - Host interface allows processor to communicate via SMBus and slave interface allows an external microcontroller to access system resources
  - Compatible with most two-wire components that are also I2C compatible
- AC-Link for Audio and Telephony CODECs
  - Supports AC ’97 2.3
  - Support for up to six channels of PCM audio
  - Third AC_SDATA_IN line for three codec support, and independent bus master logic for seven channels (PCM In/Out, Mic 1 input, Mic 2 input, modem in/out, S/PDIF out)
  - Separate independent PCI functions for audio and modem output (full AC3 decode)

For additional information, refer to the following:

- Intel® 82801DBM I/O Controller Hub 4 (ICH4-M) Datasheet (252337-001): http://www.intel.com/design/mobile/datashts/252337.htm

- Intel 82801DBM I/O Controller Hub 4 Mobile (ICH4-M) Specification Update (252663-005) http://www.intel.com/design/chipsets/specupdt/252663.htm
- Intel 82801 DB I/O Controller Hub 4 (ICH4) Datasheet (290744-001): http://developer.intel.com/design/chipsets/datashts/290744.htm
- Intel Consumer Electronics Software Downloads: http://developer.intel.com/design/celect/swd/index.htm
- AC'97 2.3 specification: http://www.intel.com/labs/media/audio
- PCI Local Bus Specification 2.2: http://www.pcisig.com

6.2.3.5 Intel® 854 Chipset Graphics

The IP-Digital Set Top Box (IP-DSTB) provides the performance and graphics support required for the digital home. The Intel 854 chipset supports the following:

- Core frequency of 250/266 MHz.
- Up to 64 MB of dynamic video memory allocation
- Digital Video Output
  - Digital Video Out ports DVOB and DVOC support up to165 MHz dot clock on each 12-bit interface; two 12-bit channels can be combined to form one dual channel 24-bit interface with an effective dot clock of 330 MHz
  - The combined DVO B/C ports as well as individual DVO B/C ports can drive a variety of DVO devices such as third-party TV encoders (see Recommended Materials List for an example of DVO-compliant vendors)
- 1.25-V AGTL host bus supporting 32-bit host addressing
- Hub interface to ICH4-M
- Integrated graphics capabilities, including 3D rendering acceleration and 2D hardware acceleration
- Integrated 350-MHz RAMDAC
- Supports a variety of third-party TV Encoders to allow for TV encoding from the Intel 854 chipset DVO
- Software support:
  - Validated graphics drivers for Windows* CE 5.0 and Linux
  - TPV TV encoder support includes NTSC, PAL, and additional formats

For additional information, refer to the following:

- Intel Consumer Electronics Components and Designs: http://developer.intel.com/design/celect
- Intel 854 Chipset Datasheet (contact your local Intel representative for this document)
- Intel Consumer Electronics Software Downloads http://developer.intel.com/design/celect/swd/index.htm

6.2.3.6 Motherboard

For motherboard implementation details, refer to the *Intel® 854 Platform Design Guide.*

6.2.3.7 BIOS

For BIOS implementation details, refer to the Vendor List (Appendix A) to find a complete list of BIOS vendors currently supporting Intel 854 Chipset.

6.2.3.8 Thermal Considerations

As the processing power of consumer electronics devices increase, this naturally leads to the requirement for higher performance processors. Targeted at this market segment are processors with lower thermal requirements, such as the Ultra Low Voltage Celeron M processors that provide the performance required for consumer electronics. Most consumers would prefer no fans, since this method of cooling introduces a mechanism that can affect the lifetime of the product. In addition, fans introduce noise. For these reasons, natural convection systems are the preferred cooling method for CE devices. The design of the chassis and strategically positioned air vents will enhance cooling.

For additional information, refer to the following:

- Intel 82801DB ICH4 Thermal and Mechanical Design Guidelines: http://www.intel.com/design/chipsets/designex/29865102.pdf
- Thermal Considerations for Passive SetTop Box Design (available from your local Intel representative)
- Intel 854 Thermal Design Guide (available from your local Intel representative):

6.2.4 Set-top Box Middleware

Set-top box middleware differs from retail consumer electronics middleware because it integrates and manages the delivery of streaming content of IP at both the head-end and set-top box client. This software typically controls capabilities including media asset management, billing, and customized programming. At the head-end, the solution enables operators to customize programming lineups, track billing and account information based upon delivery of customized content, and update viewing rates. In the home, the set-top box can receive remote software updates and communicate ordering of on-demand content, as well as enable consumers to create viewing profiles and parental controls. This middleware is usually licensed from the middleware ISV directly to the service provider or operator and can feature a recurring revenue model based on various and flexible licensing models.

6.3 Digital Media Recorder (DMR)

6.3.1 Platform Overview

The Digital Media Recorder (DMR) design described in this document consists of a suggested hardware configuration for a stand alone consumer electronics device. The DMR is designed for recording and sharing digital content including video, movies, photos and music files.

6.3.2 Multifunction Capability

The Digital Media Recorder configuration will accommodate a variety of digital and analog signals from a separate IP-Digital set top box (IP-DSTB) or tuner and includes an IDE interface to a hard drive and/or an optical storage device to record digital-media. Figure 17 is a sample block diagram of a Digital Media Recorder using Intel Architecture building blocks.

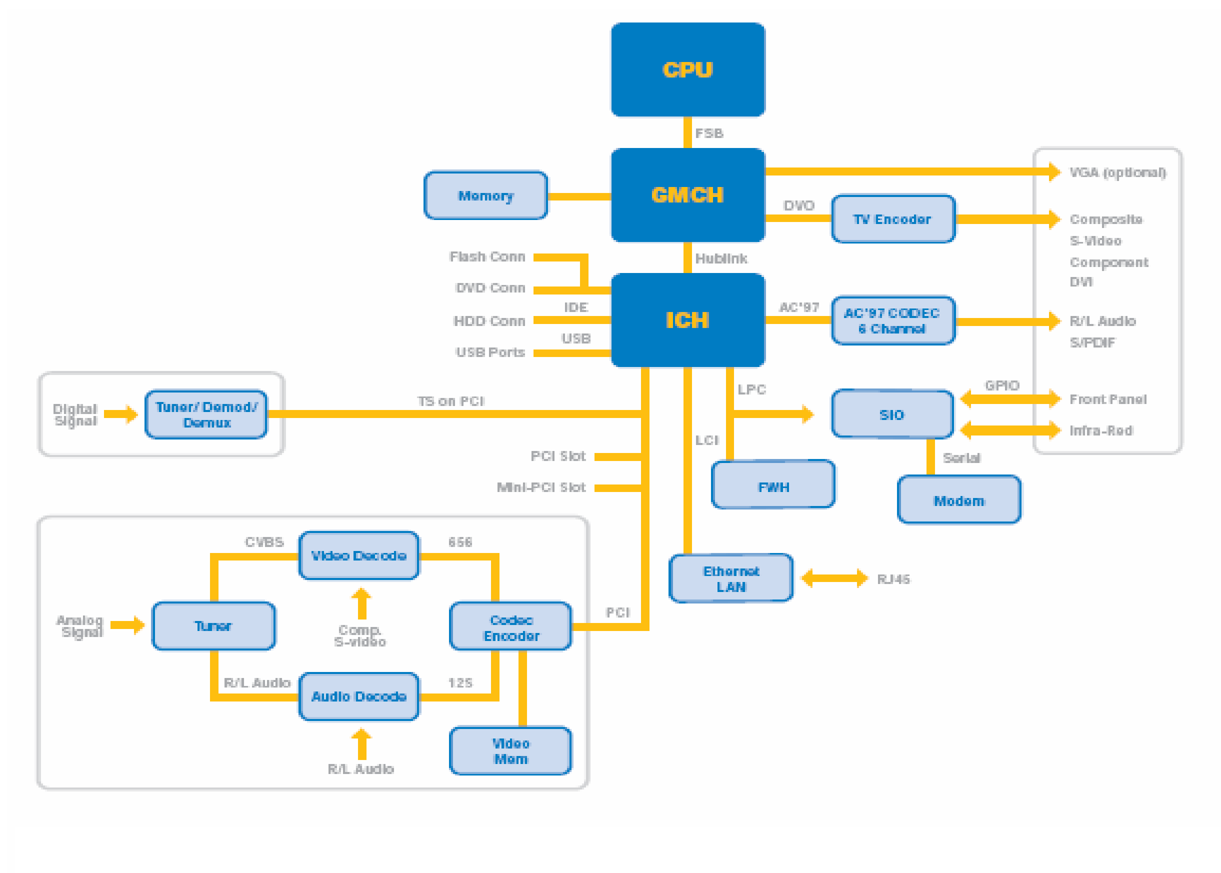


Figure 17. Digital Media Recorder Configuration Based on Intel Architecture

6.3.3 Digital Media Recorder Usage Model Framework

This section summarizes the key use models necessary in the DMR market segment. Core usage models are those that are minimum requirements for platforms built in the 2005 timeframe. Target usage models are enhancements that utilize some of the advanced features in the Intel platform.

Emerging usage models are those that are gaining adoption on high-end platforms, being explored for advanced service models or being researched for feasibility, proof-of-concepts, and other technology showcases. Table 6 summarizes the usage model framework.

Table 6. DMR Usage Model Framework

	Core	Target	Emerging	Comments
EPG	X			
PVR	X			
DVD playback	X			
DVD recording	X			
Basic DVD authoring		X		
Trickle VoD		X		
DMA	X			
Content sharing		X		
VoIP			X	Internet-based provider
Video phone			X	Internet-based provider
Online gaming			X	Internet-based provider
Health monitoring			X	Internet-based provider
Remote education			X	Internet-based provider
Home security			X	Internet-based provider

Table 7 provides the platform components list.

Table 7. DMR Platform Components List

Technology	Features
Processor	Intel® Celeron M Processor
	400 MHz front side bus
Motherboard	Intel® 854 chipset
	ICH4-M I/O Controller Hub
	PC2100/2700 DDR SDRAM
	AGP 2X/4X connector
	DVOB/C digital video output via ADD connector
	Two IDE controllers with ATA/100
	Six USB 2.0 ports
	Integrated LAN controller
	AC '97 controller with 6 channel sound
Memory	256 MB SDRAM memory down on board [DDR support for 854]
Add In Cards	TV encoder
	TV tuner card via PCI
Storage	One PATA 120 GB hard disk drive
	DVD-ROM disk drive
Chassis	Consumer Electronics form factor / DSTB chassis
	Integrated voltage regulator on board
Peripherals	IR remote control
	Microphone (for VoIP)
Software	Embedded operating system
	DVD player
	Digital photo editing
	DVD burning
	Digital Media Receiver (DMR) host software
	Electronic Programming Guide (EPG)
	Personal Video Recorder

6.3.4 Intel Processor

The Intel® 82854 GMCH supports the Intel Celeron® M Processor. The front side bus operating at 400 MHz supports a 64-bit host data bus, with 32-bit addressing. For the optimal thermal solution, the performance of the ULV Intel Celeron M Processor at 600 MHz is the fit for consumer electronics applications.

For additional information, refer to the following:

- Intel CeleronM Processor Datasheet (300302-003): http://www.intel.com/design/mobile/datashts/300302.htm
- Ultra Low Voltage Intel Celeron M Processor at 600 MHz Addendum to the Intel(R) Celeron M Processor Datasheet (301753):

http://www.intel.com/design/intarch/datashts/301753.htm

- Intel 854 Platform Design Guide (contact your local Intel representative for this document)
- Intel Consumer Electronics Software Downloads: http://developer.intel.com/design/celect/swd/index.htm

6.3.5 System Memory

The system should include support for at least one 128 MB DDR SDRAM memory down for a CE specific implementation.

- Double Data Rate (DDR) SDRAM
- Directly supports one DDR SDRAM channel, 64 bits wide
- Supports 266/333 MHz DDR SDRAM devices with max of two, double-sided DIMM (four rows populated) with unbuffered PC2100/PC2700 DDR SDRAM
- Supports 128-Mbit, 256-Mbit, and 512-Mbit technologies providing maximum capacity of 1 GB with x16 devices and up to 2-GB with high density 512-Mbit technology

Recommended system configuration of memory depends on the actual application the system will be running in the home. Systems can be populated with memory down if frequent hardware upgrades are not required. For platform scalability, an additional DIMM slot can be included to provide for memory upgrades to allow flexibility for more memory intensive processing. For digital media recorders, more memory is required to support the bandwidth required to support decoding to the hard drive, and encoding during playback; at least 256 MB of memory is required for DMR needs.

6.3.6 I/O Controller Hub (ICH4-M)

The features of the ICH4-M are as follows:

- Integrated IDE Controller that supports Ultra ATA/100/66/33 with independent timing of up to four drives, with separate primary and secondary IDE cable connections
- PCI Bus Interface
  - Supports PCI Revision 2.2 Specification at 33 MHz with 133 MB/sec maximum throughput
  - Supports up to six master devices on PCI
- Low Pin Count (LPC) Interface
  - Supports super I/O chips for PS/2 keyboard and mouse support
  - Supports firmware hub to interface with BIOS
- Power Management Logic
  - Supports ACPI-defined power states
  - ACPI power management timer
  - PCI PME# support, SMI# generation
  - All registers readable/restorable for proper resume from 0 V suspend states
- Universal Serial Bus (USB)
  - Includes three UHCI host controllers that support six external ports, including one EHCI high-speed USB 2.0 port and a host controller that supports all six ports
  - Supports wake-up from sleeping states S1–S5

  - Supports legacy keyboard/mouse software
- Integrated LAN Controller
  - WfM 2.0 and IEEE 802.3 compliant providing 10/100 Mbps Ethernet support
  - Connected via LAN Connect Interface (LCI)
  - Uses Intel 82562ET/EM LAN connect components
- SMBus
  - Supports SMBus 2.0 Specification
  - Host interface allows processor to communicate via SMBus and slave interface allows an external microcontroller to access system resources
  - Compatible with most two-wire components that are also I^2C compatible
- AC-Link for Audio and Telephony CODECs
  - Supports AC'97 2.3
  - Support for up to six channels of PCM audio
  - Third AC_SDATA_IN line for three codec support, and independent bus master logic for seven channels (PCM In/Out, Mic 1 input, Mic 2 input, modem in/out, S/PDIF out)
  - Separate independent PCI functions for audio and modem output (full AC3 decode)

For additional information, refer to the following:

- Intel 82801DBM I/O Controller Hub 4 (ICH4-M) Datasheet (252337-001): http://www.intel.com/design/mobile/datashts/252337.htm
- Intel® 82801DBM I/O Controller Hub 4 Mobile (ICH4-M) Specification Update (252663-005) http://www.intel.com/design/chipsets/specupdt/252663.htm
- Intel® 82801 DB I/O Controller Hub 4 (ICH4) Datasheet (290744-001): http://developer.intel.com/design/chipsets/datashts/290744.htm
- Intel Consumer Electronics Software Downloads: http://developer.intel.com/design/celect/swd/index.htm
- AC' 97 2.3 specification: http://www.intel.com/labs/media/audio
- PCI Local Bus Specification 2.2: http://www.pcisig.com

6.3.7 Intel® 854 Chipset Graphics

The DMR provides the performance and graphics support required for the digital home. The Intel 854 chipset supports the following:

- Core frequency of 250/266 MHz.
- Up to 64 MB of dynamic video memory allocation
- Digital Video Output
  - Digital Video Out ports DVOB and DVOC support up to165 MHz dot clock on each 12-bit interface; two 12-bit channels can be combined to form one dual channel 24-bit interface with an effective dot clock of 330-MHz
  - The combined DVO B/C ports as well as individual DVO B/C ports can drive a variety of DVO devices such as 3rd party TV encoders (see RML for an example list of DVO compliant vendors)
- Hub interface to ICH4-M

- Integrated graphics capabilities, including 3D rendering acceleration and 2D hardware acceleration
- Integrated 350 MHz RAMDAC
- Supports a variety of third-party TV Encoders allow for TV encoding from the Intel chipset digital video output
- Software support:
  - Validated graphics drivers for Windows* CE 5.0 and Linux
  - TV encoder support includes NTSC, PAL, and SECAM formats

For additional information, refer to the following:

- Intel Consumer Electronics Components and Designs: http://developer.intel.com/design/celect
- Intel 854 Chipset Datasheet (contact your local Intel representative for this document)
- Intel Consumer Electronics Software Downloads http://developer.intel.com/design/celect/swd/index.htm

6.3.8 Motherboard

For motherboard implementation details, refer to the *Intel® 854 Platform Design Guide.*

6.3.9 BIOS

For BIOS implementation details, refer to the Solutions Vendor List (Appendix A) to find a complete list of BIOS vendors currently supporting Intel® 854 Chipset.

6.3.10 Thermal Considerations

As the processing power of consumer electronics devices increase, this naturally leads to the requirement for higher performance processors. Targeted at this market segment are processors with lower thermal requirements, such as the Ultra Low Voltage Celeron M processors that provide the performance required for consumer electronics. Most consumers would prefer no fans, since this method of cooling introduces a mechanism that can affect the lifetime of the product. In addition, fans introduce noise. For these reasons, natural convection systems are the preferred cooling method for CE devices. The design of the chassis and strategically positioned air vents will enhance cooling.

For additional information, refer to the following:

- Intel 82801DB ICH4 Thermal and Mechanical Design Guidelines: http://www.intel.com/design/chipsets/designex/29865102.pdf
- Thermal Considerations for Passive SetTop Box Design (available from your local Intel representative)
- Intel 854 Thermal Design Guide (available from your local Intel representative):

6.4 Digital Media Adapter (DMA)

A Digital Media Adapter (DMA) is a device that broadens the availability of the consumer's digital media content, making it accessible in other rooms of the house and on other devices. A DMA makes use of the wired or wireless home network to access, receive and render digital content from

the Entertainment PC (ePC) and display that content on a TV or stereo system in another room of the house.

For example, if users stores music and videos on an ePC in the den, they might consider adding a DMA to the bedroom TV. The DMA can connect over the home network to view the available content on the ePC in the den or using other devices throughout the home. Internet resources including Internet radio enable users to choose the content they want and then arrange to stream it to the DMA. The DMA then plays the audio and displays videos or photos on the bedroom TV, with the convenience of a remote control. Some DMAs enable Web browsing, or subscriptions to premium music or video services.

While DMAs vary in features and functionality (for example some may be capable of only audio, and others may offer near-DVD quality video), their architecture is relatively simple. In fact, DMA functionality is being integrated into more and other CE devices including Networked DVD Players or Connected DVD Players.

Figure 18 illustrates a sample DMA architecture:

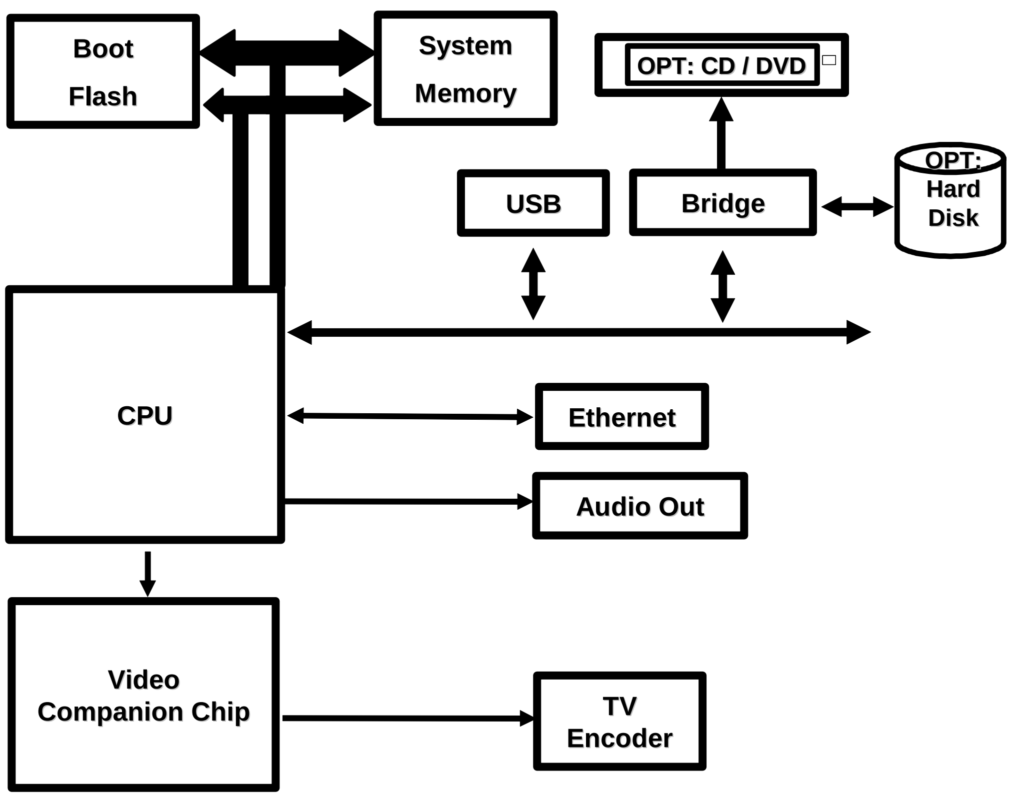


Figure 18. Sample DMA Architecture

In order to enable smooth interoperability with other devices, including the ePC, vendors implementing DMA solutions are expected to increasingly support the DLNA Home Networked Device Interoperability Guidelines. These industry guidelines focus on enabling better interoperability among CE devices by specifying a common framework for media management and control across the home network; and the DLNA organization itself enables certification and “plugfests” to help CE vendors deliver compliant products that work seamlessly together.

Appendix A IP-DSTB / DMR Solutions Vendor List

Table 8. IP-DSTB/DMR Solution Vendors

Vendor Name	Vendor Focus	Vendor URL
Akimbo	Middleware, applications, CE Devices Service provider, and infrastructure solutions	http://www.akimbo.com/
ANT	Multimedia building blocks and browser	http://www.antlimited.com/
Broadstream	Middleware, applications, and services	http://www.broadstream.com/
BSQUARE	Multimedia building blocks, solutions and services	http://www.bsquare.com/
Edgestream	Middleware and applications	http://www.edgestream.com/
Espial	Middleware, applications, and browser	http://www.espial.com/
Handan	Original Equipment Manufacturer	http://www.handan.co.kr/
LuxSAT	Applications, CE devices, and infrastructure solutions	http://www.luxsat.com/
Mediabolic	Middleware and applications	http://www.mediabolic.com/
Media Excel	CODECs and multimedia building blocks	www.mediaexcel.com/
Micro-Star International	Original Development Manufacturer	http://www.msicomputer.com/
Microsoft	Operating system / BIOS, BSP, middleware, multimedia building blocks, CE devices	http://www.microsoft.com/
Myrio	Middleware, applications, and CODECs	http://www.myrio.com/
NetCentrex	Service providers and infrastructure solutions for VoIP	/http://www.netcentrex.com/
Oregan Networks	Middleware, applications,and browser	http://www.zicorp.com/links/oregan.htm
Reddline	VoIP services	http://www.reddline.com/
Samsung	Original Equipment/Development Manufacturer	http://www.samsung.com/
Skelmir	Multimedia building blocks	http://www.skelmir.com/
Sonic Solutions	Middleware and applications	http://www.sonic.com/
Tatung	Original Equipment/Development Manufacturer	http://www.tatung.com/
Thomson	CE devices and Solutions Integrator	http://www.thomson.net/
Wyse	Original Development Manufacturer	http://www.wyse.com/

Appendix B Definitions

Table 9 provides the definitions of terms used in this document.

Table 9. Definitions

Term	Definition
ADD	AGP Digital Display
AES	Advanced Encryption Standard
ATA	Hard disk drive standard interface
BSP	Board Support Package
CA	Conditional Access: The “descrambling” technology that enables a set top box to display premium content from service providers (such as Dish Network, Comcast, or DirecTV)
CELP	Consumer Electronics Linux Platform
CP	Content Protection: Method of securing content from unauthorized use.
DMA	Digital Media Adaptor
DMI	Digital Media Infrastructure
DRM	Digital Rights Management: Policy that defines the rights of usage for media content.
DTCP	Digital transmission content protection
DVI	Digital Video Interface
EAS	External Architecture Specification
EDID	Extended Display Identification Data
EPG	Electronic Program Guide: Interactive program guide and menu that provides listing of all available media content available from service provider (such as Dish Network, Comcast, Direct TV, and TiVO)
FSB	Front Side Bus. Also referred to as Processor Side Bus
GOP	Group of Pictures (MPEG2)
HDCP	High Definition Content Protection
HDMI	High Definition Digital Media Interface
IP-DSTB	Internet Protocol Digital Set Top Box: A device with built in Conditional Access that decodes and displays media content from a DSL or Ethernet-based connection
ISV	Independent Software Vendor
LV	Low Voltage: generally used in reference to specific microprocessors
MC	Media Center (also known as “Multi-TV Digital Set Top Box”)
MDSTB	Multi-TV Digital Set Top Box: A set top box that provides whole home video/PVR services and contains conditional access.

Table 9. Definitions (continued)

Term	Definition
Media Content	Broadcast audio and video; personal audio and video, and pictures.
PDD and MDD	Platform-Dependent Driver and Model Device Driver (Win CE specific)
PIP	Picture in Picture: The capability of video overlay of a second (usually smaller) video window
PSP	Platform Support Package
PVR/DVR	Personal/Digital Video Recorder: Provides ability to time-shift and store media content. Includes Electronic Program Guide capability (EPG)
RPM	Redhat Package Manager
SAS	Software Architecture Specification
Serve	Ability to distribute broadcast and local media content to other devices in the digital home
Service Provider	The entity that supplies the household with television programming typically on a subscription basis. Typical examples are DirecTV for satellite and Comcast for Cable TV. Some service providers are able to provide PPV or VoD content for additional one-time fees above the subscription.
SHC	Secure Hash Check
Source	1) Discover content and display list of content to the end-user. 2) Location where the content resides, or is served from.
Stream	A single channel of continuous media content
Time Shifting/PVR “Trick” Modes	The buffering of broadcast media streams, allowing for VCR-like features (such as pause/resume, fast forward, or reverse)
VANC	Vertical Ancillary: Data space used to hold closed captioning data
VoD	Video on Demand: A service provided by a service provider where a consumer can choose movies to watch “on demand” from a list of premium releases for a fee.
VoIP	Voice Over Internet Protocol: Using the Internet as the transmission medium for telephone calls by sending voice data in packets using IP rather than by traditional circuit transmissions of the PSTN
WLAN	Wireless Local Area Network: A local area network that transmits over the air typically in the 2.4 GHz or 5 GHz unlicensed frequency band.

Appendix C Wireless Technologies

WLAN Technology Overview

When discussing 802.11, it is important to have a basic understanding of the terminology and the meaning of the different extensions. This section will review the highlights of both 802.11a and 802.11b/g, as well as define some additional technology extensions.

Technology Advancements Overview

What is 802.11

The 802.11 standard was developed by the IEEE committee to specify an "over the air" interface between two wireless devices. These wireless devices can be stations (clients) or a base station (Access Point). At a high level, 802.11 WLAN is similar to wired Ethernet except for the medium in which the data is transferred. For 802.11 the medium is "air" and for wired Ethernet (802.3) it is wires.

What is Dual-Band

Dual-band refers to a WLAN device that is capable of supporting both 802.11a and 802.11b/g technologies. Currently dual-band solutions operate in a switched or mutually exclusive mode. This means that the dual-band WLAN NIC is only capable of supporting one network (802.11a or 802.11b/g) at a time. The radios do operate simultaneously; however they are incapable of supporting more than one connected network at a time. By upgrading the software capabilities and Graphical User Interface (GUI), a user could be notified when another network is available and provide an option for a seamless switch.

The advantage of implementing a dual-band wireless solution is that it is compatible with existing 802.11a and 802.11b/g networks and provides high performance and connectivity to the existing infrastructure. The end user no longer needs to decide which technology to implement, as they will be able to operate and connect in both modes. Systems that are compatible with 802.11a, 802.11b, and 802.11g are said to be tri-mode capable.

Definition of Standards

The 802.11 standard uses lettered extensions to differentiate between different versions of the early wireless specification. Listed below is a brief explanation of some approved standard extensions and also those that are expected to be approved in the coming year. For more detailed information and status updates, refer to the 802.11 WLAN Working Group at: (http://grouper.ieee.org/groups/802/11/).

PHY, as used below, refers to the digital and radio components of the physical layer, required to meet the individual specification.

- 802.11a – This is referred to as a High Rate PHY for 5 GHz Unlicensed National Information Infrastructure (U-NII) frequency band. It was developed to take advantage of the available unlicensed spectrum that was made available. It is capable of obtaining theoretical data rates of

54, 48, 36, 24, 18, 12, 9, and 6 Mb/s. It achieves these data rates by using a modulation scheme called Orthogonal Frequency Division Multiplexing (OFDM).

- 802.11b – PHY extension for 2.4 GHz Industrial Scientific Medical (ISM) frequency band to increase performance of earlier 802.11 PHY. It uses Direct Sequence Spread Spectrum (DSSS) and Complimentary Code Keying (CCK) to achieve theoretical data rates of 11, 5.5, 2, and 1 Mb/s.
- 802.11g – PHY extension to increase performance in 2.4 GHz ISM frequency band. It is backward compatible with 802.11b and adds an increase in performance up to 54 Mb/s. It achieves this by implementing the same OFDM method as with 802.11a.

The following specifications are still under development:

- 802.11e – This extension defines requirements for adding Quality of Service (QoS) to the current 802.11 specifications. Provides performance enhancements for voice, audio, video, and overall system performance.
- 802.11h – Enhancements to the 5 GHz PHY to improve network management. It provides for dynamic channel selection, output power control and channel energy measuring.
- 802.11i – Security enhancements and improvements to the current 802.11 specifications

Appendix D RFQ/RFP Example Template

The following information was created by Intel's Consumer Electronics Group as a means of providing service providers and OEMs with insights into feature and functionality elements inherent in IP-DSTB products. This has been used successfully to help CEG customers identify and assess key attributes for the products they are requesting and delivering. The following terms are used in the tables of Hardware and Software functional requirements contained in this section.

Priority (P)	1: High or "must have" 2: Medium or "nice to have" 3: Low or "wish list" Note: The priorities listed are suggested, the customer should determine the final requirements)
Risk (R)	1: High development risk – uses uncertified or unproven technology, low experience level 2: Medium development risk – present but manageable risks 3: Low development risk

Table 10. Logic Core Requirements

ID	Feature Name	Requirements	Comment	P	R
1.0	**Processor Core Complex**				
1.1	CPU	High Performance, low power processor from Intel. The performance level needs to be sufficient to support gaming and the decoding of Internet content such as QuickTime* and Real Media*. Lower voltage CPU with low power consumption supports the thermal sensitive solution	Additionally, High performance suggested to allow for software decoding of a variety of video and audio algorithms. This will: • Reduce cost (no hardware decode) • Maximize flexibility (can accommodate future algorithms) High performance Intel® technology enables delivery of processing intense applications for "Triple/Quad play"	1	3
1.2	Main Memory	128 MB to 512 MB of SDRAM (PC 133) or DDRAM (PC 2100 or faster)	Memory type depends on system architecture, 512 MB allows for many operating system/user options.	1	3
1.3	Programmable / Re-programmable Memory	1 MB to 64 MB of flash memory to be used to: • "boot" or startup the system • contain the entire operating system (assume no Hard Drive is present) • Allow for customization or feature "add-ons" • Run diagnostics • Report Tampering It is assumed that if large amounts of Flash memory is needed that it will be connected to the ATA I/O port	The amount of flash memory needed is highly dependent on the implementation and features desired in the system.	1	3
1.4	Other Memory	Support for removable Flash devices, including some or all of the following: USB, Compact Flash, SD, Memory stick, Smartmedia	Allows for interoperability with other devices including cameras and MP3 players	2	3

Table 11. I/O Requirements

ID	Feature Name	Requirements	Comment	P	R
2.0	**Processor core Input/Output**				
2.1	USB 1.1	Multiple USB 1.1 channels to allow for connection to: • Flash card reader • Keyboard • Mouse • Game Pad • Front Panel LCD (if needed) • IR Device (if needed)	USB allows for significant flexibility in terms of system design. Many variations of one platform can be realized by employing USB as a standard interface. Additionally, these options can be located either inside or outside of the basic unit.	1	3
2.2	USB 2.0	Multiple USB 2.0 channels to allow for connection to all of the above plus: • Hard Drive • DVD • CD • Video Camera	See comments above	1	3
2.3	ATA-100	Allows interface to “standard” PC based hard disks, CD-R/W and DVD+-R/W-RAM devices as well as Compact Flash memory.	While the ability to interface to a hard disk is not targeted for this design. The ability to operate from a hard disk is valuable in the development and debug phase of the product. As mentioned in section 1, the ATA port is used to interface to the flash memory	1	3
2.4	Serial ATA	Allows interface to “standard” PC based hard disks, CD-R/W and DVD+-R/W-RAM devices. This would be a more “future looking” design than the standard ATA-100	See comments in the field above. Additionally, a few years from now, because of high PC volumes, Serial ATA devices may be less expensive than ATA devices.	2	2
2.5	PCI expansion	Allows interface to standard PC hardware either via direct interface to integrated circuits or via a Cardbus adaptor.	Needed if interfacing to either custom or “off-the-shelf” PC hardware is required.	2	3
2.6	IEEE-1394a	Allows interface to DV cameras	Needed if interfacing to DV cameras if required		
3.0	**Communication Oriented Input/Output**				
3.1	Main input 10/100/1000 Base-T	Standard RJ-45 (CAT 5) connection with auto sensing 10/100 that complies with the IEEE802.3 and IEEE802.3u specification. Gigabit Ethernet is optional.	This interface would provide the means for customers to interface to the DSL modem. It would be the primary data I/O of the unit.	1	3
4.0	**Audio / Video Input / Output**				
4.1	Video Output Format	PAL-D	Standard Television format in the Europe, China, etc.		
4.2	Video Output	For completeness, the following should be supported: • Composite Video • S-Video • Component Video • Digital Video	This allows the best quality connection to almost any consumer display device.	1	3
4.3	Video Output Option	15 pin VGA connection	Allows the device to be connected to a standard computer monitor	2	3
4.4	Audio Output	For completeness, the following should be supported: • RCA* Left/Right • S/PDIF o Optical o Digital	In current audio equipment this is considered to be a minimum number of outputs. The S/PDIF could be eliminated, but surround sound could not be supported.	1	3
4.5	Audio Output Option	RCA outputs	Allows for providing decoded 5.1 audio channels.	2	3

Table 12. A/V Decoding Requirements

ID	Feature Name	Requirements	Comment	P	R
5.0	**Video Decoding**				
5.1	MPEG-2* (ISO/IEC-138180)	Supporting: • Half-D1 (360x480) • Full-D1 (720x480) It is assumed that the average bit rate would be between 2 and 4 MBPS.	Allows for playback of standard MPEG-2 encoded material. The quality is assumed to meet "standard" expectations with no blockiness of "stuttering". Transport stream and encrypted transport stream should be supported. Assume software decoding for maximum flexibility	1	3
5.2	MPEG-4 (ISO/IEC-14496)	Supporting ISO/IEC-14496 • Simple Profile • Advanced Simple Profile • Half-D1 (360x480) • Full-D1 (720x480) (Contd.) It is assumed that the average bit rate would be between 1 and 2 MBPS.	Allows for playback of MPEG-4 encoded material. Transport stream and encrypted transport stream should be supported. Assume software decoding for maximum flexibility.	1	3
5.3	Other Algorithms	Windows* Media Version 9 It is assumed that the average bit rate would be between 2 and 4 MBPS.	Could become a standard in the future.	2	3
5.4	Other Considerations	3D Graphics	Ability to support 3D Graphics could be a means to product differentiation	2	3
6.0	**Audio Decoding**				
6.1	MPEG-1	Supporting Audio: • MPEG-1 Layer 1 • MPEG-1 Layer 2 • MPEG-1 Layer 3 (MP3)	Cover all "standard" MPEG audio types.	1	3
6.2	MPEG-4	AAC required to support the standard audio format for MPEG-4 video streams.		1	3
6.3	Multichannel Audio Formats	Including: • AC3* • DTS* • SDDS*	Optional formats. If multichannel S/PDIF is supported, either AC3 or DTS is required because consumer receivers can only decode AC3 and S/PDIF multichannel audio	2	3

Table 13. Software Protocol Requirements

ID	Feature Name	Requirements	Comment	P	R
7.0	**Communication Protocols**				
7.1	Support multiple Communications Standards	Including: • TCP/IP • UDP/IP • RTP • RTSP • NTP • HTTP • FTP • TELENET • SNMP • Multi and Unicast Streaming	Allows for the greatest communication flexibility of the unit. The need for any specific protocol will be determined by the customer	1	3
7.2	Web Browser	Including: • Macromedia* • IMAP (MIME) • HTML v4.0 • JavaScript* v1.3 • American input	Allows for the option to browse the Web with this unit	2	3
7.3	Gaming	Support included for basic Internet Gaming	Needed if gaming support is required	2	2
8.0	**Operating System**				
		Support for: • Linux* 2.4 or above (Embedded Linux) • Windows* CE.net 4.2 or 5.0	Allows for "customization"	1	2

Table 14. System Attributes

ID	Feature Name	Requirements	Comment	P	R
9.0	**Security**				
9.1	Support for secure receiving content	Support for DRM	Insure digital output streams (USB/IEEE-1394a) are encrypted.	2	3
9.2	Support tamper resisting the unit	Could be electrical or mechanical	Needed if it is desired that the user not be allowed to modify the unit.	2	2
10.0	**Environmental**				
10.1	Physical	Standard "Consumer Electronic" form factor is assumed			
10.2	Electrical	<30 watts		1	3
10.3	Power Supply	AC 176 ~ 250V 50/60 Hz, 35W	Low voltage processor desirable in order to; 1) reduce power and 2) make "fanless" designs possible	1	2
10.4	Continue playtime	> 72 hours		1	3
10.5	Startup time	< 60 seconds		2	3
11.0	**Remote Control**				
11.1	IR	Standard or custom protocol		1	3
11.2	Microphone	Standard protocol	Facilitates gaming applications	2	3

Appendix E Service Provider Overview

Introduction and Background

For purposes of this brief introduction, a service provider (SP) will be classified as the local telephone company that typically provides voice, data, and (in the near future) video services to its customers. These SPs are often referred to as a Telco, or as an Incumbent Local Exchange Carrier (ILEC). In addition, but not included in the scope of this section are Service Providers that provide video, data and now voice services over a cable and coaxial infrastructure. They are known as Multiple Service Operators (MSO), or more commonly the cable company. A final class of service provider, although not as widespread in North America, but quite evident in Europe, is Satellite Service Providers. Examples of each SP classification include:

- Telco/ILEC: SBC, Verizon, Korea Telecom, NTT, British Telecom, Telefonica, and others
- MSO/Cable: Comcast, Rogers, Time-Warner Cable, and others
- Satellite: EchoStar/Dish Network, Direct TV, Voom, and others

The focus of this overview is on the Telco, or ILEC. These SPs have been providing voice communications as part of the global communications infrastructure from shortly after the invention of the telephone more than 130 years ago. For the better part of their existence, Telcos were traditionally regulated by state and federal governments and operated free of competition. In the late 1960s/early 1970s, landmark judicial decisions ushered in an era of competition for Telcos. In the mid 1990s, many government-owned Telcos in EMEA and APAC were privatized as a means of generating revenue for national interests, and infusing an element of private ownership in the Telco.

Technology and Culture

Although communicating in and of itself is not an exact science, the communications infrastructure that facilitates it across the world is governed by a highly organized, integrated, and defined set of standards, architectures and process that aid in the efficient, economical, and expedient connection of calls, transportation of data and delivery of content virtually anywhere on earth. In addition, advances made possible by cellular technology introduced in the early 1980s have enhanced the accessibility and mobility of communications on the planet.

Of primary importance in the future role of communications is the change that is occurring in the Internet infrastructure. Although we have made the Internet a part of our daily personal and professional lives, it is staggering to think that this phenomenon has been part of our communications network for barely more than five years. Mass market adoption of high-speed connections over DSL and cable dates from about 1997. Today, it is incomprehensible to think that any company would not have a Web site, or anyone would not have an e-mail address. Moreover, for sons and daughters barely beyond diapers in 1997, the need for IM, text messaging and photos on cell phones is as common essential as Mickey Mouse Club on TV after school to their parents and grandparents.

Service Providers – Circa 2005-10

Given the preceding mix of culture, technology, competition, communications applications and history, one might ask what does the successful SP of tomorrow look like. The answer is that the mantra of communications anytime, anyplace, anywhere, with anyone on any device is likely to become more and more evident over the next five years.

Spurred by increasing competition, advances in technology, consumer interest in new services, and landmark revenue-generation opportunities associated with the Internet, service providers are competing to be the provider of choice for consumers. Aggressive plans are already in motion to address the major changes that will become evident. Examples of potential service provider initiatives over the next five years include:

- **Architecture**: IP- based telephony (voice, data and video) is likely become the mainstream communications format of choice due principally to the economy, efficiency and revenue generation opportunity it offers the consuming public. IP will supplement and ultimately supplant the traditional ATM based communications infrastructure.
- **Networks**: Wireline and wireless convergence mean that ultimately the home telephone line, fax line, e-mail address and cellular telephone number could become totally merged, converged and transparent. Phones, PDAs, PCs, laptops, and other devices will be capable of providing voice, data, text, video, pictures, movies, songs—and a monthly bill.
- **Applications**: Triple play (voice, data and video) and quad play (add games to the preceding three) applications will become the standard for communications intensive users. Ordering, accessing, delivering and billing for user defined content…when, where and how the user wants it will become the replacement for trips to video rental stores.
- **Competition**: Behind each of the preceding applications lies the backdrop of revenue generation or revenue loss. Telco's see the inevitable erosion of their recurring revenue streams tied for more than 100 years to the monthly telephone bill as MSOs introduce and package IP voice telephony with their existing high-speed cable and video services. While at the same time, MSOs see the video service initiatives of Telco's coupled with voice and data as broadside hits to their monthly cable revenue.
- **Regulation**: It is probably impossible to close a discussion on service providers without mentioning the role of government regulation. Once thought of as simply a "utility", most people in the world today are viewing communications as a resource that is essential to daily living. Regulatory changes can spur opportunities for service providers.

Intel and its affiliated business groups are positioned with service providers to both influence their direction and help to move the CE market segments forward. Intel is working to meet service provider requirements with Intel Architecture-based products that are functionally comprehensive, competitively priced, and supported by Intel resources. Signs throughout 2004, have pointed to a new aggressive spirit among service providers to move quickly forward. The good news so far for Intel and its customers is that service providers are looking to Intel as one of the mainstream players to help them achieve their goals.

Appendix F Technical Challenges

Intel is working to develop solutions to meet the technical challenges that will enable the addition of streaming video and other capabilities within the digital home and to meet customer-driven initiatives.

Streaming Video in the Digital Home

Streaming content in general refers to media that can be consumed while it is being obtained rather than waiting for the media to be downloaded or fully available in a local device before being consumed. With the advent of high speed Internet and the networked home revolution, streaming video is set to replace other types of media delivery throughout the home. While today's digital home consists of many stand-alone devices and gadgets, each requiring their own hard media interfaces and specific connectivity, the future digital home will consist of many interoperable devices where content stored on one device is available to other devices to consume. Streaming video is the main driving force behind the connected digital home vision, due to its high network and CPU bandwidth requirements as compared to other types of streaming content.

Home Network Bandwidth Constraints

The network bandwidth requirements imposed by streaming video require high-speed network access throughout the home. Due to network bandwidth constraints, compressed video (such as MPEG-2, MPEG-4, or H.264) is expected to be the predominant near-term solution for streaming video. The main challenge in enabling the digital home vision is the penetration of this type of multimedia networks in the home. According to Parks Associates research[2], about 42 percent of U.S. households will have Internet broadband access by 2007. About 35 percent of households with broadband access had home networks by the end of 2003, and it is expected to follow a similar rate. However, the worldwide penetration of home networks is still very low. According to Reed Electronics Group, the worldwide household penetration of multimedia networks is expected to be less than 2 percent by 2006[3]. As consumers become more educated and technology becomes more mature and easy to use, these numbers are expected to grow exponentially. The widespread diversity of standards and protocols makes this more challenging, as it is not clear at this point what will be the converged standards-based solution for home networking interoperability.

Home Network Bandwidth Constraints

CPU speed and platform performance is the second challenge to be addressed to make streaming video quality a comparable solution to today's analog TV signals. Today's standards require 30 frames/second of interlaced video to be displayed without visible compression artifacts. To allow for a glitch free viewing experience, rendering platforms must ensure enough processing power to fully decode and render the encoded bit stream, while keeping headroom for other more sophisticated use cases. These processing requirements will increase with the advent of HDTV.

Today's general purpose computing platforms are not well equipped to handle this type of load in order to be comparable to fixed purpose hardware solutions. Figure 19 presents a high level picture of an MPEG encoder and decoder. During encoding (content generation), most CPU cycles are spent on the motion estimation block where a block matching function is used to identify the frame macro-block on a reference frame that will minimize the coding error. On the decoding end

[2] Parks Associates – Broadband Network Households, 2004.
[3] In-Stat MDR – Multimedia Home Networks: An Evolutionary Process, Reed Electronics Group, 2002.

(playback) most cycles are spent on the motion compensation block, which is the inverse transformation of the Motion Estimation. Other compute intensive blocks are the floating point transforms (Discrete Cosine Transform and its inverse).

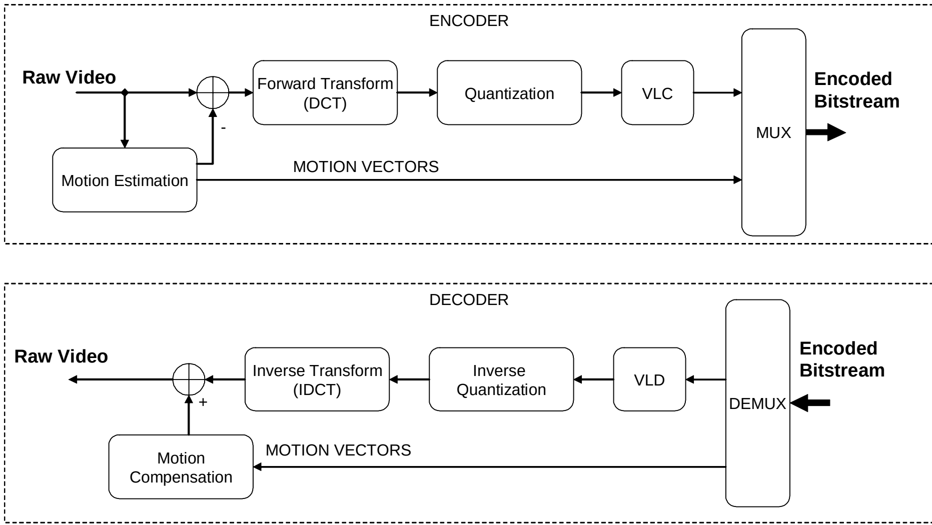


Figure 19. High level diagram of a typical MPEG video encoder and decoder

Another important limiting factor is the lack of interoperability standards to allow real time, low latency video transfer throughout the home. Most existing standards and protocols were not designed to handle these new usage models. For example, the HTTP protocol uses a pull-model, where clients (playback devices in this case) will request the video content off a server. The protocol was designed for handling web content and therefore it's based on a "render-after-download" work model. Also, the diversity of compression formats and the flexibility in the design of the underlying CODECs causes market confusion and slow down progress toward fully interoperable solutions.

In most widely adopted compression standards, such as MPEG or VC1, most video frames are encoded with dependencies on previous or future frames in the bit-stream. These include P (predictive) and B (bi-directional) frames. Only certain frames, called I-frames (for Index frames) are coded as independent frames that can be randomly accessed within the formatted bit stream (see Figure 20). The bit cost for I-Frames is higher than that of P and B frames. MPEG does not impose a requirement of the frequency and periodicity of I-Frames and codec implementations will take advantage of this to reduce the stream bit rate. This presents a challenge as trick mode cannot be implemented just by selectively decoding frames. As consequence arbitrary scan speeds incur in wasted processing cycles for decoding frames that will be ultimately dropped.

In Figure 20, arrows show the dependency between frames. I-frames are encoded independently from other frames, P-frames have dependency only on previous frames, and B-frames have both forward and backward dependencies.

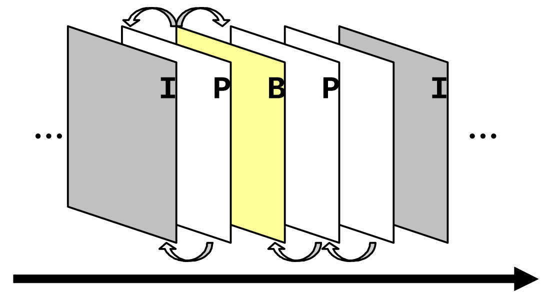


Figure 20. Encoder Frames Dependency for MPEG-2 Video Compression

A second challenge present in a network streaming environment is the absence of the *full* media content on the local device, to enable random access. Designing for trick modes in this scenario requires buffering or caching mechanisms imposing requirements for large amounts of processor caches or system memory. Even then, only a limited time window can be made available local to the device. Thin clients with limited system memory and no hard media sub-component will have limited trick mode capabilities and poor transition quality.

Optimizing network bandwidth to enrich the user experience is a common digital home goal that imposes design challenges when enabling trick modes. As an example, say the end user is fast-forwarding streaming video through the network. The serving endpoint is not aware of the client operation m ode and will be serving full bit rate media through the network, even when the client is ignoring most of the content. This translates into wasted network bandwidth that can be saved for other devices. Standards based transport protocols must offer interoperability mechanisms between serving and rendering endpoints to make them aware of playback states, in order to optimize network bandwidth.

Intel Interoperability Solutions

Intel is driving industry standards to ensure interoperability between devices and consistency in media formats and transport. DLNA and Intel NMPR guidelines address consistent media formats and transport mechanisms that enable smooth trick mode transitions. The foundations of these guidelines are found in UPnP. DLNA guidelines introduce new HTTP headers and mechanisms to allow trick mode playback by either of the following options:

- Making a server endpoint feed media at the requested speed
- Using standard headers for the media rendering endpoint to request ranges of data.

This allows thin clients to operate with lower system memory while allowing smooth trick transitions. It also optimizes network bandwidth as only the data required to satisfy a trick mode request is transported through the network. Intel is also driving Quality of Service (QoS) standards solutions into DLNA that will enable dynamic bandwidth allocation prioritization (or de-prioritization) during trick-mode playback.

Along with driving standards based solutions, Intel develops tools and provides optimized software stacks to enable customers with the latest and greatest technologies. The DMI interoperability stack developed within the Intel Consumer Electronics Group is a DLNA- based optimized solution that uses these and other Intel developed technologies to enrich user experience for state of the art trick-mode playback. This will be offered as an “out of the box” solution to significantly decrease development costs and time-to-market.

Customer-Driven Initiatives

These are some of the technology areas requested by Intel customers are currently not being covered by existing standards.

Digital Content Management Service

The anticipated explosion in storage capacity and processing power available to consumer electronic equipment is opening immense possibilities for home networking. This will be facilitated by the UPnP standard that is expected to prove a major benefit to consumers by enabling simple and reliable connectivity between stand-alone devices, and easy configuration into a home network. Without any need for user intervention, a new UPnP-enabled device is automatically registered and configured into the network, including an announcement of the services and content the device has available.

Management of content, however, which may be distributed over many devices, remains a challenge for the industry, as this is not directly addressed by any currently-available solution including the UPnP standard. The aim of this service is to give users easy access to their stored content distributed over several servers on a home network (comprising wireless and/or wired Ethernet links). The location of the content is irrelevant to users as they wish only to know what content and rendering devices (such as a TV, PC monitor, or audio player) are available. The user interface therefore displays only the content list with no information on content location. If a particular device is switched off, its content is grayed out to indicate that it is not currently available. Users can organize content by, for example, artist or genre, and can nominate specific default players on the network – music to the living-room hi-fi system or video to the living-room television – unless redirected by the user to another player. Users are also able to browse through video frames and watch trailers, search through and annotate photographs to create slide shows, organize content and make play lists[4].

Put another way, this means finding media that the user is interested in and then determining if the media is in a format consistent with the rendering device that is to be used. Content management relevant information within the UPnP A/V framework is metadata that is stored in the DMS along with the content itself in the form of XML language elements.

The design of the DMS device within the DMI suite takes a generalized and abstracted approach to the creation, storage and retrieval of metadata. All metadata are stored via a database engine within the DMS device.

Metadata that are general in nature (such as the title of a movie) are represented in the database only once no matter how many differing formats (for example, MPEG-2, VC1, or MPEG-4) the content may actually have. This simple approach is possible because the associations between metadata elements are completely flexible because they are described abstractly through database relations. Associations between metadata and the actual content are made only when necessary and appropriate. Adding a new type of metadata simply means adding to existing database tables to reflect the desired relation in the schema of the metadata database.

Network-Wide Device Reservation

Today's devices are usually controlled directly by consumers via either control buttons on the device itself, like play-, stop-, pause buttons on an video player, or via a close-range IR remote control. In a network environment users are interested in services, not primary devices and their

[4] Spation :Phillips Research center, 2004

location. Network administration issues like service addressing, discovery, control, reservation and security should not be an issue of the consumer, but should be automatically handled by the network and (middleware) services. UPnP [8] already solves part of these issues like addressing, discovery, and basic control. But it still has some shortcomings, namely device reservation, security and setup of remote user interfaces.

In many current products the roles and status of the user are clear from context of proximity. If someone is watching a video using a player, someone else will not stop or pause the video. Because of the proximity between the service provider and service consumer it is clear the player is already in use. In a networked environment, the actual provider of the service can be located at different location (such as a different room) than the consumer of the service. For example, a networked personal video recorder (PVR) located in the meter box can be controlled from every room in the home, or even outside the home using a mobile device. So, in a networked situation it is not clear if a service is already in use by someone else because there is no relation between the location of the service provider, the consumer and other consumers. When this PVR has resources to provide one single video stream, there is only one consumer that can use the device. Home Networking Software should provide means to reserve devices or inform users about the availability of their services.

Finally, you managed to download the videos of the World Series highlights to the Families PVR. You want to watch this video again and again. Every one in the family uses this PVR to watch movies and downloaded videos. How do you reserve and control this PVR?

In order to add device and service reservation capabilities to Home networking software, we formulated the following high-level requirements for such a reservation service:

- Get exclusive access to a device for a specific period of time. This will enable a user to use a device for a specific period of time without the possibility of another user hindering the use of this device by the current user.
- Schedule exclusive access to a device. By scheduling actions on specific devices on a specific point in time it is possible to 'reserve' a device for future use. For example when a device such as a digital VCR is needed for a scheduled recording action.

Negotiate or override exclusive access. The system should not be totally rigid. Once a device is exclusively accessible by a specific user, it is still possible for another user to request exclusive access to the device. Users can negotiate on the possibility of the initial user dropping exclusive access so the other user can get exclusive access. This can be the case when a digital radio tuner is reserved and in use by someone to listen to music, and another user wants to use the tuner to listen to an important news-bulletin. The music listening user can give up its exclusive access in favor of the other user. More importantly, when in case of an emergency a device like a smoke alarm needs access to all audio/video devices to inform residents and visitors about the danger-situation, overriding possible ongoing reservations.

Two UPnP service templates must be introduced to support these requirements. First, a ResourceManager template for sub-devices offering resources, such as UPnP services, to enable handling exclusive and scheduled-exclusive access. Second, a ReservationOwner-template for controlling devices, which might take action in a negotiation, to enable these devices to communicate to and from users, is supporting negotiation. When one or both services are included in specific sub-devices, these devices will be able to support reservation, canceling conflicting usage of devices between different users of the network. The UPnP Security Working Committee is currently working on the definition on devices and services supporting this functionality, but with

the addition of a number of security measures such as the use of certificates by control points to force security[1].

CEG is also developing flexible policy management mechanisms that are easily tailored for specific products. The Device Availability module tracks the current and future availability of serially re-usable resources. Using DA, applications are able to quickly determine resource availability and make future reservations. DA deals with details like mutually exclusive access to the device calendars, safe-guarding reservations across power events, and even normalizing schedules across time zones.

The Policy Store captures the conflict resolution rules associated with limited available devices. The policy store is capable of premising rules on a number of predefined variables including time, requesting device and content description. In addition, applications may define their own vectors along which to manage device access. The result is an extremely capable and flexible mechanism for expressing everything from simple autonomous rules to the multi-layered, usage-dependant rule suites. The actual storage mechanism for policy rules is hidden behind an abstract interface allowing adopters to choose the most suitable approach for their device.

The Policy Editor is an engine designed to create rules for addition to the Policy Store. It provides a programmatic API to retrieve, modify, add and delete rules from the Policy store. The Policy Editor is equally capable of supporting simple DMAs with standard policies to the most sophisticated PC-based rule-management applications.

High-bandwidth Digital Content Protection (HDCP)

HDCP is a specification developed by Intel to protect digital entertainment content across the DVI interface. The HDCP specification provides a robust, cost-effective and transparent method for transmitting and receiving digital entertainment content to DVI-compliant digital displays. The HDCP license contains robustness and compliance rules that ensure that HDCP implementations protect the confidentiality of keys and other values from compromise and deliver the desired protection for high-value video content. To meet these requirements, the HDCP Upstream Protocol has been developed to facilitate the implementation of HDCP on personal computers and other open platforms. On these platforms, the HDCP source device functionality is typically performed by a combination of the graphics hardware and video source application/middleware.